ARCHIVES OF OPHTHALMOLOGY

VOLUME 28 (old series Volume 85) SEPTEMBER 1942 NUMBER 3

COPYRIGHT, 1942, BY THE AMERICAN MEDICAL ASSOCIATION

UVEITIS WITH POLIOSIS, VITILIGO, ALOPECIA AND DYSACOUSIA (VOGT-KOYANAGI SYNDROME)

HONORIO F. CARRASQUILLO, M.D.

UTUADO, PUERTO RICO

The obscure condition of uveitis with poliosis, vitiligo, alopecia and dysacousia (known also as the Vogt-Koyanagi syndrome) is definitely accepted as a clinical entity. The disease is characterized by severe spontaneous bilateral uveitis accompanied by canities, white areas in the skin and falling of the hair and is often associated with disturbances of hearing. It has a protracted course, responds poorly to treatment and usually ends in partial or complete blindness.

HISTORICAL REVIEW

The first case report was made by Vogt [1] in 1906. He described the association of nontraumatic idiopathic uveitis with poliosis. His patient also had alopecia, though only brief mention was made of the fact. Vogt considered the conditions present as constituting one disease. In 1929 Koyanagi,[2] after having observed 6 cases, published an article containing a full description of the disease and a table of 16 cases reported by him and other writers. Babel [3] (1939) suggested that the disease be called the Vogt-Koyanagi syndrome. However, Ogawa [4] (1934) and Sugimoto

Thesis submitted to the faculty of the Graduate School of Medicine of the University of Pennsylvania in partial fulfilment of the requirements for the degree of Master of Medical Science (M.Sc. [Med.]) for graduate work in ophthalmology.

1. Vogt, A.: Frühzeitiges Ergrauen der Zilien und Bemerkungen über den sogenannten plötzlichen Eintritt dieser Veränderung, Klin. Monatsbl. f. Augenh. **44**:228-242, 1906.

2. Koyanagi, Y.: Dysakusis, Alopecia und Poliosis bei schwerer Uveitis nicht traumatischen Ursprungs, Klin. Monatsbl. f. Augenh. **82**:194-211, 1929.

3. Babel, J.: Syndrome de Vogt-Koyanagy (uvéite bilatérale, poliosis, alopécie, vitiligo et dysacousie), Schweiz. med. Wchnschr. **69**:1136-1140 (Nov. 4) 1939.

4. Ogawa, U.: Ueber die pathologische Anatomie der sog. idiopathischen Uveitis mit Dysakusis und Poliosis, Acta Soc. ophth. jap. **38**:1005-1014, 1934; German abstract, ibid., pp. 68-69.

and Kodama [5] (1937) used the names of these two observers to designate the disease as a type in the classification of idiopathic uveitis with poliosis and leukoderma.

Long before the publication of Vogt's report, the symptoms included in this syndrome had been recognized in conjunction with other ocular lesions. In the twelfth century an Arab physician, Mohammad-al-Ghâfiqî,[6] recognized poliosis of the eyelashes, which he regarded as a disease. In 1873 Schenkl [7] reported a case in which silvery white lashes appeared during sympathetic ophthalmia. Jacobi [8] published a similar observation in 1874 on a patient with the same disease in whom canities of the upper and lower lids developed. Nettleship [9] (1883) described a case observed under Hutchinson at Moorfields some years before and made the following statement:

> Cases of spontaneous destructive iridocyclitis in both eyes are of course not so exceedingly rare, and the occasional occurrence of these peculiar changes in the eyelashes (poliosis) both in them and in ordinary sympathetic inflammation, strengthens the probability that the pathological processes are the same in the two groups of cases.

In 1892 a case was observed by Tay,[10] who stated that whitening of the eyelashes and sympathetic ophthalmia are not a mere coincidence, as had been maintained by Deutschmann.

Prior to Koyanagi's [2] report, the association of deafness with ocular disease had been discussed by Peters,[11] according to whom the first case in which this association occurred was mentioned by Snellen,[12] who in 1881 presented a case of sympathetic ophthalmia and deafness at the International Medical Congress, in London. Peters cited 6 additional cases, including 1 of his own, in which such association had been estab-

---

5. Sugimoto, S., and Kodama, T.: Beiträge für den klinischen und histologischen Befund von sog. idiopathischer Uveitis mit Leucoderma und Poliosis, Acta Soc. ophth. jap. **41**:1526-1544, 1937; German abstract, ibid., p. 111.

6. Mohammad-al-Ghâfiqî: Guide d'oculistique, translated by E. Meyerhof, Barcelona, Masnou, 1933, p. 46.

7. Schenkl, A.: Fall von plötzlich aufgetretener Poliosis circumscripta der Wimpern, Arch. f. Dermat. u. Syph. **5**:137-139, 1873.

8. Jacobi, J.: Vorzeitige und acute Entfärbung der Wimpern, beschränkt auf die Lider eines sympatisch erkrankten Auges, Klin. Monatsbl. f. Augenh. **12**:153-161, 1874.

9. Nettleship, E.: A Case of Sympathetic Ophthalmitis with Whitening of the Eyelashes, Tr. Ophth. Soc. U. Kingdom **4**:83-84, 1883-1884.

10. Tay, W.: A Case of Symmetrical Whitening of Eyelashes and Eyebrows in Connection with Sympathetic Ophthalmia, Tr. Ophth. Soc. U. Kingdom **12**: 29-30, 1891-1892.

11. Peters, A.: Sympathische Ophthalmie und Gehörstörungen, Klin. Monatsbl. f. Augenh. **50**:433-439, 1912.

12. Snellen, H.: Sympathetic Ophthalmitis, the Mode of Its Treatment and Nature, Tr. Internat. M. Cong. **3**:31-35, 1881.

lished. He also reported information received by him from institutions for the blind at Neukloster and Steglitz, Germany. In the former institution the cases of blindness due to sympathetic ophthalmia included 5 in which there was impaired hearing; the second institution reported 5 instances of partial deafness among 15 cases of sympathetic ophthalmia.

Komoto,[13] reporting his first case of this syndrome in 1911, noted that Gilbert [14] had published in 1910 an article concerning a patient with vitiligo in whom bilateral optic neuritis and iritis later developed and that he considered the two conditions parts of one disease. Komoto also stated that seven years earlier he had presented at an ophthalmologic meeting a case of sympathetic ophthalmia in which there had developed circumscribed vitiligo of the forehead.

In the same periodical, just before Komoto's case report, there is an article by Erdmann [15] in which he described in detail a case of bilateral inflammation of the choroid, nontraumatic in nature and accompanied by vitiligo and poliosis. He placed the condition in the category of heterochromic inflammation and attributed the vitiligo to the same cause. Judging from his description, the case was one of the Vogt-Koyanagi syndrome, although it does not appear in Koyanagi's table.

With respect to alopecia, I have found no report of its coexistence with any ocular disease before Vogt published his case in 1906. Even he did not attach any particular significance to this symptom.

ETIOLOGY

The specific etiologic factor in the disease is unknown. The condition shows wide geographic distribution. Although the greatest number of case reports are from Japan, cases have been observed in the United States, the West Indies, Mexico, South America, Europe and China. The disease does not show racial predilection.

Age does not seem to be a determining factor, although most of the patients reported on have been between the ages of 30 and 40 years. Rones [16] reported on a patient aged 10, and Babel [3] observed a patient 52 years of age.

Sex does not play a significant role. Of 45 patients, 25 were males and 20 females.

---

13. Komoto, J.: Ueber Vitiligo und Auge, Klin. Monatsbl. f. Augenh. **49**:139-142, 1911.

14. Gilbert, W.: Vitiligo und Auge, ein Beitrag zur Kenntnis der herpetischen Augenerkrankungen, Klin. Monatsbl. f. Augenh. **48**:24-31, 1910.

15. Erdmann, P.: Zur Frage eines Zusammenhanges zwischen Vitiligo und Augenleiden, Klin. Monatsbl. f. Augenh. **49**:129-138, 1911.

16. Rones, B.: Uveitis with Dysacousia, Alopecia and Poliosis, Arch. Ophth. **7**:847-855 (June) 1932.

The only case in which consanguinity was mentioned was that reported by Zentmayer.[17]

Social condition is not a factor, since cases have been found among all classes.

Familial constitutional disturbances have been mentioned only by Bunge.[18] In his report, 2 sisters had premature canities at 36 years of age.

As with any obscure condition, consideration has been given to syphilis and tuberculosis as possible factors. Demaria [19] stated the belief that these two diseases play the most important etiologic role and advocated careful investigation in this respect. Of 32 cases in which serologic examination was carried out, there was a positive reaction for syphilis in 7, and in 4 of these the reaction was reported as only "weakly positive" (Komoto,[13] Avalos [20] and Yanes and Ferrer [21]). With this low incidence, syphilis cannot be considered a causative factor.

Tuberculin tests were made in only 16 cases, in 4 of which the reaction was positive. Hence tuberculosis may also be excluded as a causative factor.

The most important symptom of the disease, sine qua non, is a severe bilateral nontraumatic uveitis, the cause of which has not yet been ascertained.

Syphilis and tuberculosis head the list of systemic infections which may produce nontraumatic uveitis. If to these one adds focal infections one has the important trio of infective agents. However, the peculiarity of the uveal manifestation of the disease considered here is its association with cutaneous lesions and disturbances of hearing.

In 1920 Baldino [22] cited a number of instances in which observers had reported uveitis in association with changes in the pigment and in the hair and disturbances of the "sympathetic endocrine system." He stated the belief that the disease with which they were dealing was due to a disturbance of the sympathetic endocrine system. He called atten-

17. Zentmayer, W.: Personal communication to the author.

18. Bunge, E.: Ueber doppelseitige Iridozyklitis und Poliosis, Arch. f. Augenh. **108**:212-225, 1933.

19. Demaria, E. B.: Consideraciones sobre dos casos de iridocicloroiditis doble y grave en sujetos con vitiligo, Arch. de oftal. hispano-am. **17**:355-362 (July) 1917.

20. Avalos, E.: (*a*) Un nuevo caso de uveitis bilateral grave acompañada de sordera, calvicie y canicie, Rev. cubana de oto-neuro-oftal. **1**:242-247 (July-Aug.) 1932; (*b*) Uveitis grave bilateral acompañada de canicie (caso clínico), ibid. **1**: 238-241 (July-Aug.) 1932.

21. Yanes, T., and Ferrer, O.: Uveitis doble espontanea con disacusia, alopecia y poliosis, Rev. cubana de oto-neuro-oftal. **7**:5-18 (Jan.-Feb.) 1938.

22. Baldino, S.: Irido-coroidite di origine endocrino-simpatica, Arch. di ottal. **27**:244-260, 1920.

tion to the symmetry of the cutaneous lesions, so well illustrated in my case (figs. 1, 2 and 3), which he considered as doubtless the result of active or passive intervention on the part of the innervation. He referred to cases in which iridocyclitis had occurred with trigeminal nerve lesions (sympathetic fibers) and incipient facial hemiatrophy.

Weekers [23] reported such a case at a meeting in 1920 of the Belgian Ophthalmological Society. Kalt [24] observed lesions of the choroid in a case of facial hemiatrophy, as did Van Duyse the elder [25] in 1919. Also mentioned was a case observed by Cassirer and reported by Steindorff [26] in 1914. The patient was a woman aged 20 of a nervous family and herself exhibiting evidence of general nervousness. Her mother suffered from neurodermatitis and her father from exophthalmic goiter. Ptosis of the left eye developed in the patient after a strain associated with fear. The pupil was contracted (sympathetic oculopupillary symptom). The cilia, supercilia and hairs of the lip became gray.

Concerning an endocrine influence, Baldino gave the following information: Chevallereau [27] reported to the French Ophthalmological Society in 1911 4 cases of exudative choroiditis associated with ovarian dysfunction. Mooren observed cases of iritis in women during the menstrual period. Cohn, Danthoin, Woods, Pressel, Courserant and Dor [28] published cases of inflammation of the uveal tract during puberty which regressed after the onset of menstruation.

In 1912 Komoto [29] reported a case of deafness in sympathetic ophthalmia. He referred to "cerebral deafness" in sympathetic ophthalmia as mentioned by de Wecker [30] ten years before. The latter author attempted to explain the condition by migration of micro-organisms along the optic nerve and the base of the cranium to the acoustic nerve. Komoto emphasized the fact that the condition was a true cerebral deafness and said that its occurrence could be reasonably explained by a slight meningitis which attacked the acoustic nerve directly or by metastasis. He recalled the frequent occurrence of disease of the labyrinth in syphilis and in mumps.

---

23. Weekers, L.: Hémiatrophie faciale et symptômes oculaires, Bull. Soc. belge d'opht. **40-43**:23-33, 1919-1921.

24. Kalt, E., cited by Berger, in Lagrange, F., and Valude, E.: Encyclopédie française d'ophthalmologie, Paris, Octave Doin, 1906, vol. 4, p. 76.

25. Van Duyse, M., in discussion on Weekers.[23]

26. Steindorff, K.: Vitiligo der Lider und Poliosis nach stumpfer Verletzung, Klin. Monatsbl. f. Augenh. **53**:188-193, 1914.

27. Chevallereau, A.: La choroïdite exsudative disséminée d'origine génitale, Bull. et mém. Soc. franç. d'opht. **28**:146-154, 1911.

28. Cohn, Danthoin, Woods, Pressel, Courserant and Dor, cited by Baldino.[22]

29. Komoto, J.: Ein Beitrag zur Taubheit bei sympathischer Ophthalmie, Klin. Monatsbl. f. Augenh. **50**:129-135, 1912.

30. de Wecker, L.: Complications extraoculares de l'ophthalmie sympathique, Ann. d'ocul. **126**:248-254, 1901.

In 1912 Peters,[11] following the works of Elschnig [31] and Kummel,[32] which explained sympathetic ophthalmia as an anaphylactic manifestation through sensitization to the uveal pigment, assumed that the same phenomenon could explain the occasionally coexistent disturbances of hearing. He mentioned the fact that there is some pigment in the basilar membrane of the labyrinth and that the disintegration of this pigment, as it occurs in the uvea, brings about the disturbance of hearing. His hypothesis has been discussed by Koyanagi, who found no basis for the anaphylactic theory because in his cases the aural symptoms appeared at the same time as the uveal changes. He asserted that some time would of necessity have to elapse before the antigen (the disintegrated uveal pigment) could have its anaphylactic action on the pigment in the labyrinth. Other authors disputed this theory from an anatomic and physiologic standpoint, since the pigment content of the basilar membrane is normally absent or, if found, is only accidental, and its physiologic role had not been determined.

Weskamp,[33] on the other hand, made use of Peters' suggestion and introduced the following question:

> As the majority of the symptoms observed in the disease originate in tissues rich in pigment, why could it not be possible to explain everything as the result of an anaphylactic process originating in the destruction of the uveal pigment, which, acting as an antigen, could provoke in the organism the formation of antibodies capable of exercising a lytic action on the pigmented tissues?

In 1913 Cramer [34] reported a case of sympathetic ophthalmia following removal of a luxated lens in a woman aged 38. Disturbances of hearing were present, and alopecia and poliosis developed three months after the operation. Cramer was a firm believer in Peters' hypothesis, which he confirmed by his own experimental work. Blood from an enucleated human eye affected with sympathetic ophthalmia was injected into rabbits, with the result that there was marked loss of hair in the animals.

In 1926 Calogero [35] proposed a different explanation for the auditory disturbances occurring in sympathetic ophthalmia. He expressed the

---

31. Elschnig, A.: Studien zur sympathischen Ophthalmie: II. Die antigene Wirkung des Augenpigments, Arch. f. Ophth. **76**:509-546, 1910.

32. Kummel, R.: Ueber anaphylaktische Erscheinungen am Auge, Arch. f. Ophth. **77**:393-408, 1910; Experimentelles zur sympathischen Ophthalmie, ibid. **79**: 528-544, 1911.

33. Weskamp, R. L.: Uveitis exudative bilateral con disacusia, poliosis, alopecia y desprendimiento retiniano, Arch. de oftal. de Buenos Aires **7**:728-741 (Dec.) 1932.

34. Cramer, E.: Zur Frage der anaphylaktischen Entstehung der sympathischen Entzündung, Klin. Monatsbl. f. Augenh. **51**:205-206, 1913.

35. Calogero, G.: Sui disturbi auricolari nell'oftalmia simpatica, Arch. di ottal. **33**:499-519 (Nov.) 1926.

opinion that the association of the uveitis and the disturbances in the labyrinth is established via the sympathetic nerves, which form a plexus around the carotid artery and through the petrosal nerves. Filaments of the carotid plexus enter the uvea, and some also reach the labyrinth. He asserted that whenever the filaments in the choroid are irritated those going to the internal ear transmit the disturbance to the labyrinth.

Koyanagi [2] questioned this manner of transmission. He cited Abe's [36] experimental work on herpes in animals. In Abe's experiments the cranial symptoms, such as salivation and tooth gnashing, were accompanied by a peculiar rotation of the head and neck, indicating disturbed coordination. This he attributed to a lesion of the acoustic nerve root, which would account for the disturbance in hearing. According to Koyanagi, the herpes virus, which has great affinity for the brain tissue and produces encephalitic phenomena, may at the same time give rise to an ocular condition closely resembling sympathetic ophthalmia in man, which is similar to the spontaneous uveitis in the disease discussed here. He claimed that the disturbances in hearing may be caused by the same agent which produces the uveitis. He also stated that, even though the deafness may occur simultaneously with the uveitis, it can be due to another factor.

It is pertinent to state that at the present time the association of the dysacousia with the uveitis has been well established and is regarded as an integral part of the syndrome.

At the 1929 meeting of the Puerto Rico Medical Association, Dr. J. H. Font [37] presented a case of temporary auditory disturbance resulting from "nervous shock." A girl 18 years of age had been badly frightened during the night, and the following morning she was completely deaf. Hearing was restored after some time.

The other associated symptoms (vitiligo, alopecia and poliosis) have also been explained by the anaphylaxis theory of Peters, although experimental verification is lacking.

In 1932 Rones [16] performed cutaneous tests with uveal pigment in 3 cases, in only 1 of which there was a positive reaction. He explained the 2 negative reactions by the fact that the condition had existed long enough for desensitization to occur. A similar test was made possible in my case through the courtesy of Dr. Alan C. Woods, of the Johns Hopkins Hospital, who furnished a 3 per cent solution of uveal tissue. No superficial reaction at the area of injection was noticed. Two weeks later a section of the skin was removed and sent to Dr. Woods for

36. Abe, T.: Experimente über die durch Herpesvirus erzeugte sympathische Ophthalmie (von Szily) unter besonderer Berücksichtigung der Fortleitungsbahn, Arch. f. Ophth. **117**:375-398, 1926.

37. Font, J. H.: Unpublished case, presented at the meeting of the Puerto Rico Medical Association, 1929.

histologic examination. The report was negative. As in Rones's 2 cases, the disease had been present for a long time (nearly two years) before the test was made. Dr. Woods [38] reported having made pigment tests in several cases of sympathetic ophthalmia, the results usually having been positive.

Experiments by Pouchet [39] in 1876 and studies by Frisch [40] in 1910 proved experimentally the relation of pigment cells in the skin of fish to the sympathetic nervous system.

The cause of vitiligo is unknown. Ormsby [41] stated that the condition occurs most commonly during the second and third decades of life; that it is present in association with or after certain cutaneous diseases; that it is seen in myxedema, exophthalmic goiter and syphilis; that some authorities believe it to be toxic in nature; that it frequently occurs in neurotic persons, and that at times it follows local trauma.

In many instances nervous shock or depression seems to be the exciting factor. I have personal knowledge of 2 cases in which vitiligo occurred suddenly and with no apparent cause other than these two factors. In the first instance a woman aged 60 was thrown from a horse. There was no severe injury, but the patient was unconscious for two days, probably as a result of severe cerebral concussion. Four days after the fall, while the patient was still in bed, spots of vitiligo began to appear on the hands, and later such spots occurred on other parts of the body. The family physician diagnosed the condition as vitiligo caused by nervous shock following the fall. In the second case a man aged 70 suffered severe depression after destruction of his property by a hurricane. Soon afterward spots of vitiligo appeared on his body. There was no cause other than the patient's mental state to account for the cutaneous condition.

In this connection it is interesting to note that in a case reported by Weskamp [33] the complex of symptoms occurred shortly after psychic trauma. The patient, a 20 year old laborer, fell into a well 70 meters deep but broke his fall after dropping 30 meters by grasping a transverse pole, to which he held until help arrived. He suffered severe fright and shock. In another case, reported by Avalos,[42] the disease followed a

38. Woods, A. C.: Personal communication to the author.

39. Pouchet: Des changements de coloration sous l'influence des nerfs, Paris, 1876; cited by Steindorff.[26]

40. Frisch: Ueber die Beziehungen der Pigmentzellen in der Fischhaut zum sympathischen Nervensystem, in Festschrift zum 60. Geburtstage Richard Hertwigs, Jena, Gustav Fischer, 1910, vol. 3, p. 17; cited by Steindorff.[26]

41. Ormsby, O. S.: A Practical Treatise on Diseases of the Skin, Philadelphia, Lea & Febiger, 1937, p. 619.

42. Avalos, E.: Mi tercera observación sobre un caso de uveitis bilateral grave acompañada de sordera, calvicie y canicie, Rev. cubana de oto-neuro-oftal. **5**:75-79 (May-June) 1936.

state of hysteria. In still another case, described by Demaria,[19] the poliosis and vitiligo initiated the symptoms, appearing suddenly after a difficult labor.

The causes of poliosis, or premature graying, were given by Ormsby [43] as heredity, deficient nutrition or innervation of the hair follicles and functional and organic nervous conditions (fright, facial atrophy). Many authors have reported its association with ocular disease or trauma.

The coincidence of poliosis and sympathetic ophthalmia was cited by Schenkl [7] in 1873, Jacobi [8] in 1874, Nettleship [9] in 1883, Tay [10] in 1892, Cramer [34] in 1913 and Fialho [44] in 1930.

In 1888 Hirschberg [45] observed a girl aged 14 in whom there developed poliosis of the eyelashes and constriction of the palpebral fissure while the patient was suffering from a hordeolum of the left eye. In the same year de Schweinitz [46] observed a woman aged 18 in whom there suddenly developed white cilia of the right eye. Both eyes were myopic, but the author did not consider the myopia a causative factor.

Herzog [47] (1904) noted gray cilia in a man with symptoms of old trachoma.

Bach [48] (1905) stated that he had seen grayness of the eyelashes following injury to the eyes.

In 1913 Oesterreicher [49] observed marked poliosis of the eyelashes after trachomatous and operative scarring of the eyelids. Trophic disturbances were considered responsible for its production.

In 1925 Gasteiger [50] reported a case of poliosis of the eyelashes in a 9 year old boy suffering from parenchymatous keratitis with bilateral iridocyclitis.

Corrado [51] reported 2 cases of poliosis in 1932; one patient was a girl aged 9 and the other a man aged 55. In the first case the condition

43. Ormsby,[41] p. 1221.

44. Fialho, A., Jr.: Vitiligo und sympathische Ophthalmie; Pigmentstörungen bei den schwerer Uveitiden, abstracted, Zentralbl. f. d. ges. Ophth. **25**:121, 1931.

45. Hirschberg, J.: Plötzliches Ergrauen von Haupt- (oder Bart-) Haaren, Centralbl. f. prakt. Augenh. **12**:15, 1888.

46. de Schweinitz, G. E.: Sudden Turning Gray of the Eyelashes, Univ. M. Mag. **1**:353-354, 1888-1889.

47. Herzog, H.: Pathologie der Cilien: II., Ztschr. f. Augenh. **12**:180-243, 1904.

48. Bach, L.: Traumatische Neurose und Unfallbegutachtung, Ztschr. f. Augenh. **14**:246-251, 1905.

49. Oesterreicher, L.: Weisse Zilien, Prag. med. Wchnschr. **38**:485, 1913.

50. Gasteiger, H.: Ueber frühzeitiges Ergrauen von Zilien, Arch. f. Augenh. **95**:261-266, 1925.

51. Corrado, M.: Contributo alla genesi della vitiligine palpebrale consecutiva ad instillazioni ripetute di atropina, Ann. di ottal. e clin. ocul. **60**:914-920 (Dec.) 1932.

occurred while the patient was being treated for trachoma. In the second, after twenty-five days' atropine therapy for iridocyclitis there developed graying of the cilia together with intolerance to atropine. The author stated the belief that in both cases the poliosis was postinflammatory.

Babel [3] described a case in which poliosis occurred in the lid at the site where a few months previously a chalazion had been excochleated.

Sudden whitening of the hair (local or general) not associated with an ocular lesion has been observed relatively often. Its occurrence has been explained on neurogenic grounds.

In 1881 Reich [52] published an article concerning poliosis of nervous origin. He mentioned the fact that unilateral graying of the hair sometimes occurs in association with trigeminal neuralgia and cited a case attributed to Paget. In this case a woman who suffered violent attacks of migraine found that the day after each attack her hair had become white in several areas, but after several days the hair regained its natural chestnut color. Reich also referred to the fact that novelists and historians often speak of hair which turned white in one night as the result of terror or extreme anger. He stated that a few hours are sufficient for hair which has been filled with air to turn white. He cited a case mentioned by Cassan, according to which Lady Leclère, called for testimony in the trial of Louvel, was so perturbed mentally that her hair turned gray in a single night. Another case cited by him was that mentioned by Parry, surgeon-major at Aldershot, in India: A rebel Sepoy taken by the English troops was sentenced to death, and his hair suddenly turned gray before execution. Reich reported a case in which poliosis of the left eyelid occurred several months after iridectomy, cataract extraction and discission of the eye. The patient suffered much pain during the operation, and the author considered the poliosis of nervous origin.

In 1859 Ponti [52a] described a case of apparently spontaneous temporary graying of the eyelashes. The patient was a 26 year old woman in whom all the cilia in the left side became gray in the course of three months. He epilated the affected hairs six months after the beginning of the condition and applied to the lid margins a slightly irritant ointment. Normally pigmented lashes replaced the gray ones.

Bock [53] (1890) observed in a case of right hemicrania that all the cilia of the affected side turned gray.

---

52. Reich, M.: Péliose d'origine nerveuse, Arch. d'opht. **1**:307-314, 1880-1881.

52a. Ponti, F.: Straordinario caso de precose canigie della ciclia, Gior. d'oftal. ital. **2**:105-110, 1859.

53. Bock, E.: Ueber frühzeitiges Ergrauen der Wimpern, Klin. Monatsbl. f. Augenh. **28**:484-492, 1890.

The case reported by Roose [54] is interesting. A girl 17 years of age was suddenly frightened during the night, and the following morning the lashes of the right eye were gray. The author assumed that this was a case of "poliosis neurotica" produced by fear.

Rindfleisch [55] (1902) reported a case of graying of the eyelashes of the left side in a blonde girl 5 years of age. He attributed the condition to a general nutritional disturbance subsequent to severe catarrhal pneumonia.

In 1902 Lotin [56] reported a case of migraine on the left side in which all the cilia of that side and the supercilia of the lateral half of the right side had become gray.

The alopecia occurring in the syndrome under discussion is usually in the form of discrete patches (alopecia areata). The causation of this type of alopecia per se is obscure. Ormsby [57] listed the following theoeries concerning its origin: neuropathic, parasitic and toxic.

Koyanagi explained the loss of hair and the depigmentation by supposed pathologic transformation in the cutaneous areas, these symptoms being the result of deficient nutrition. He stated the belief that all the symptoms occur simultaneously and are produced by the same unknown agent.

In my own case the bald patches in the eyebrows and the head appeared over depigmented areas of the skin. This fact tends to indicate that the two conditions are produced by the same pathologic process.

The hair changes its color either by an increase in its air content or by an absence of pigment. The latter condition is brought about in two ways: The hair bulb or the cells manufacturing pigment, the melanoblasts, may not function, or the cells of the shaft may lose their power to retain the melanin, this being carried away by the chromatophores. These disturbances are usually the result of circulatory or nervous changes.

When there is change in the air content the whitening may be sudden, and this fact explains how canities occurred overnight in some of the cases cited. In such instances there is complete absence of pigment in the hair shaft. When a disturbance of pigment is the cause of the graying, the process occurs less rapidly, the color is less distinctly white

54. Roose: Cas de poliosis ou de canitie des paupières, Ann. de l'Inst. Saint-Antoine à Courtrai, April 1898; abstracted, Ann. d'ocul. **122**:314, 1899.

55. Rindfleisch: Ein Fall von einseitigem Ergrauen der Wimpern bei einem Kinde, Klin. Monatsbl. f. Augenh. **40**:53-56, 1902.

56. Lotin: Un cas de blancheur précoce des cils et des sourcils, Vestnik oftal., 1902; cited in Graefe, A., and Saemisch, E. T.: Handbuch der gesamten Augenheilkunde, Leipzig, Wilhelm Engelmann, 1908, vol. 5, p. 1908.

57. Ormsby,[41] p. 1236.

and a few granules of pigment may be seen between the cells of the hair shaft. This is the way in which poliosis occurs in the Vogt-Koyanagi syndrome. Vogt [1] was unable to demonstrate an abnormal air content.

In my case the gray hairs were examined microscopically, and no increase in air content was noted. The grayness was due to lack of pigment.

Since the adrenals control pigmentation, since vitiligo may be caused by ovarian hypofunction and since the skin of eunuchs is sometimes depigmented, endocrine disturbances have been cited by Gilbert [58] as a possible factor. In his first case,[14] reported in 1910, there was complete suppression of the sexual function at the age of 35, when the disease first appeared. In his other 2 cases, observed later, bilateral uveitis with vitiligo occurred in women at the climacteric. Jess [59] reported on a girl aged 13 with dystrophia adiposogenitalis. Krasnoff's [60] patient showed hypofunction of the sexual glands, the adrenal cortex and the posterior lobe of the hypophysis. Babel's patient and mine had a + 12 and a + 11 basal metabolic rate, respectively. These figures, if not pathologic, are at a high normal level. Babel's patient had a mediastinal tumor which was diagnosed as a diving goiter. My patient had a rapid pulse.

Commenting on Koyanagi's list of cases, Gilbert [58] stated that none of those in which there was a positive Wassermann reaction or any other apparent cause should be included in the group. I am not in accord with this opinion. Syphilis or tuberculosis may be the causative factor in such cases, but what proof is there other than the positive reaction to the Wassermann or to the tuberculin test that one or the other of these factors is the sole cause? The symptom complex in question is by no means common in association with these two types of infection. Although severe bilateral uveitis may occur with either, the syndrome itself may be due to some other factor. Gilbert [14] in his first case (1910) attributed the disease to a herpetic lesion without cutaneous manifesta-

58. Gilbert, W.: Gedanken und Beobachtungen zur Aetiologie der Uveitis, besonders der "unbekannten Ursprungs," Klin. Monatsbl. f. Augenh. **85**:65-79, 1930.

59. Jess, A.: Poliosis, Vitiligo und doppelseitige schwerste Iridozyklitis bei Dystrophia adiposogenitalis, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **49**: 469-473, 1932.

60. Krasnoff, M. L.: Uveitis, Vitiligo, Poliosis, Dysakusis, in Sbornik v oznamenovanie sorokaletiya naucknoy deyatelnosti zasluzhennogo deyatelya nauki M. I. Averbakha, Moscow, Gosudarstvennoe izdatelstvo biologicheskoy i meditsinskoy literatury, 1935, pp. 244-252; abstracted, Zentralbl. f. d. ges. Ophth. **37**:120-121, 1937.

tions. After twenty years, however, when he associated endocrine disturbances with the causation, he acknowledged that his former opinion had been incorrect.

Harada's disease, which is believed by some authorities to be a phase of the syndrome discussed here, has been said to be due to a virus similar to the herpes virus (Magitot and Dubois-Poulsen [61]).

Babel [3] expressed the belief that the theory of the production of recurrent iritis with aphthous lesions in the mouth and in the genitalia advanced by Behcet [62] and Franceschetti and Valerio [63] could also be applicable to the causation of the Vogt-Koyanagi syndrome.

Since the disease sometimes begins with acute general symptoms, the question is raised whether it can be produced by some other type of infection. In this connection it may be said that fever is seldom, if ever, present. Bacteriologic culture of the blood has never shown flora. All other examinations of the blood have given negative results.

The possibility of a deficiency disease may also be considered. Experiments by Morgan and Simms [64] have shown that in rats deprived of the vitamin B filtrate fraction (pantothenic acid) gray hair develops. There is no significant evidence in this respect in the cases with which I am dealing. In my case the treatment included administration of vitamins, particularly the B complex, but this had no effect on the malady.

After all these conjectural attempts to clarify the factor or factors concerned in the production of the Vogt-Koyanagi syndrome, the etiologic aspect of this disease remains unexplained.

PATHOLOGY

The observations in the few cases in which histologic examination has been carried out show some similarity to those in sympathetic ophthalmia. All the investigators have attempted to establish a relationship between these two conditions. Histologic examination has been

61. Magitot and Dubois-Poulsen: Un cas de syndrome de Harada: Uvéite grave avec décollements bilatéraux et encéphalite, Bull. Soc. d'opht. de Paris, April 1939, pp. 223-226.

62. Behcet, H.: Considérations sur les lésions aphteuses de la bouche et des parties génitales ainsi que sur les manifestations oculaires d'origine probablement parasitaire et observations concernant leur foyer d'infection, Bull. Soc. franç. de dermat. et syph. **45**:420-433 (March) 1938.

63. Franceschetti, A., and Valerio, M.: Atti Cong. Soc. oftal. ital., Firenze, 1939; cited by Babel.[3]

64. Morgan, A. F., and Simms, H. D.: Greying of Fur and Other Disturbances in Several Species Due to a Vitamin Deficiency, J. Nutrition **19**:233-250 (March) 1940.

carried out in only 4 cases. The first case studied by Matsuoka [65] was classified by him as an instance of spontaneous uveitis, poliosis and leukoderma. He examined only the iris. He found that the tissues were thickened by a moderate infiltration of round cells, epithelioid cells and plasma cells; that in the infiltrated areas there were sporadic groups of epithelioid cells but nowhere any caseation; that the anterior limiting layer was almost intact, and that the pigment epithelium was partially destroyed. This is a picture identical with that of sympathetic ophthalmia. The author stated that Dr. Kitasawa had previously made a histologic examination in a case of spontaneous uveitis with leukoderma and that he had found only lymphocyte infiltration into the uvea and the retina and had considered the disease a specific infection different from sympathetic ophthalmia. Matsuoka, however, stated the belief that these observations indicated an early stage of the disease.

Ogawa [4] examined an eye with idiopathic uveitis associated with dysacousia and poliosis. His observations differed from those of Matsuoka, notwithstanding the fact that the disease was not in an early stage, as demonstrated by the presence of scar tissue in the iris. Besides slight inflammatory changes in the cornea, sclera and conjunctiva, he saw diffuse round-cell infiltration in the iris, ciliary body and choroid. The chromatophores were definitely decreased in the choroid and were seen in groups in the outer layer. The cell infiltration consisted of lymphocytes with a few fibroblasts. Nowhere were there the epithelioid cells or giant cells so typical of sympathetic ophthalmia. The retina showed slight depigmentation of the pigment epithelium. The author concluded that the pathologic changes in this case were different from those in sympathetic ophthalmia, admitting, however, that this was not a safe conclusion, since sympathetic ophthalmia does not always present the same histologic picture.

Sugimoto and Kodama [5] classified idiopathic uveitis with leukoderma and poliosis into the following types: (1) Harada's type (acute diffuse choroiditis), (2) Vogt-Koyanagi's type (idiopathic uveitis in a limited sense) and (3) transitional type (Harada's type progressing to Koyanagi's type). These authors observed a case of the transitional type in which the histologic picture was as follows: Externally the eye was intact. The uvea showed diffuse round cell infiltration (lymphocytes, plasma cells and fibroblasts) and disappearance of the chromatophores. The pigment epithelium showed atrophy as well as hypertrophy of some of the pigment cells. The authors concluded that these changes differed from those in typical sympathetic ophthalmia and stated the belief that the two diseases are different.

---

65. Matsuoka, H.: Beiträge zur Kenntnis der pathologischen Anatomie der spontanen Uveitis mit Poliosis und Leucoderma, Acta Soc. ophth. jap. **37**:1339-1344, 1933; German abstract, ibid., p. 103.

SYMPTOMATOLOGY

The ocular symptoms are usually the first to appear. There is blurring of vision, usually bilateral. This progresses rather rapidly to almost complete blindness, vision being reduced to counting of fingers or perception of hand movements in a great proportion of cases. After this rapid progress there is some slow regression and vision improves somewhat, so that the patient is able to get about although he is far from having useful vision. In a few cases vision of 20/40 or better has been preserved, while in others complete blindness has resulted.

Examination of the eyes usually shows mild ciliary injection. In a few instances there is punctate keratitis. Precipitates are frequently found on Descemet's membrane. In the early stage floating cells are seen in the aqueous. The iris is at first congested and discolored. There is blurring of the surface markings. Later there are usually abundant posterior synechias, which in many instances cause seclusion of the pupil. A membranous exudate may cover the pupil. Atrophic changes take place in the iris. The lens may show complicated cataract. The vitreous invariably presents floating opacities. The fundus if visible may show a yellowish reflex, some edema and signs of diffuse choroiditis. Later patches of depigmentation and pigment collections may be seen. Detachment of the retina has occurred in some cases.

The visual disturbance is usually accompanied by headache and pain in the eyes and supraorbital regions. As in any case of chronic uveitis, hypotony is the rule. If there is increased tension, secondary glaucoma is present. There may be slight fever. The pain is usually not severe. Nausea, vomiting, vertigo and general discomfort occasionally occur at the onset or shortly thereafter. This type of onset, which simulates that of an acute systemic infection, may mean meningeal involvement or may be the result of labyrinthine disturbance, which occurs in many cases.

The most common associated symptom in the disease is poliosis, or premature graying, which occurs in 82 per cent of the cases. This appears rather suddenly a few weeks after the onset in the form of canities of the eyebrows, of the eyelids or of the head or any other hair-covered region of the body. It may manifest itself in patches or locks or it may be diffuse. Poliosis occasionally accompanies sympathetic ophthalmia, a fact which again emphasizes the similarity of the two diseases.

In the case under my observation, the poliosis occurred in patches over the cutaneous areas in the eyebrows and head affected with vitiligo and also involved locks of hair throughout the head. There were a few white hairs in the gluteal folds. Only a few cilia were white, as may be seen in figures 1 and 4.

In some cases only the cilia and the supercilia are affected, while in others the graying is more generalized. In the case reported by Weskamp,[33] white hair grew in one month after the head was left bald by falling out of the black hair. The condition involved the entire head as well as the eyebrows and the eyelids, so that the patient's appearance was described as resembling that of a photographic negative.

The graying of the hair may be temporary or permanent. Sometimes the normal color of the hair is partially or completely restored.

Another prominent associated symptom is the pigmentary change in the skin known as vitiligo. This is present in 62 per cent of the cases and usually appears after the onset of the visual changes. In a few instances, however, it has appeared before (Gilbert,[14] Demaria,[19] Wexler [66] and Babel [3]).

Symmetric distribution of the cutaneous lesions is characteristic (figs. 1 and 2). These lesions occur as white patches, at times disseminated over the body. They may disappear partially or entirely during the course of the disease. There is also a tendency to migration. My patient first showed symmetric patches on the forehead. These later extended to involve the rest of the face and subsequently appeared on the shoulders, chest and hands, in the lumbar region and in a large butterfly-like area on the buttocks (fig. 3).

The symptom of alopecia, which was present in the first case reported by Vogt, is also a common occurrence. It is present in 53 per cent of the cases and appears some time after the onset of the disease. It usually occurs in patches (alopecia areata). It may be limited to small areas or may be so extensive as to involve the entire head. Weskamp's [33] patient was almost completely bald. The lost hair may or may not be replaced. The new hair may be gray and is thinner, shorter and more pointed. In my case the alopecia was not marked. It occurred in the form of patches, with a few thin, short, gray hairs in the areas of vitiligo (fig. 1). There was also slight general thinning of the hair of the entire head, which tended to be progressive.

Dysacousia is the least common symptom in the syndrome. It occurs in 50 per cent of the cases. Auditory disturbances are manifested by hyperesthesia to noises, tinnitus and partial deafness. They usually appear shortly after the onset of the disease. The deafness is usually bilateral and varies in degree. These auditory symptoms, termed cerebral deafness or sympathetic deafness by Komoto,[29] when accompanying sympathetic ophthalmia are interpreted as a cerebral or labyrinthine

66. Wexler, D.: Ocular Depigmentation Accompanying Generalized Vitiligo, Arch. Ophth. **57**:393-396 (July) 1928.

extension of the disease. Otologic examination has failed to demonstrate any pathologic changes responsible for the symptoms. In many cases the deafness is transitory. In my case the auditory symptoms appeared six weeks after the onset of the syndrome and have persisted. The patient lives near a railroad, and he stated that the whistle of the locomotive caused intense pain in his ears. At the time of writing he is partially deaf.

COMPLICATIONS AND SEQUELAE

The complications found are those which may accompany any severe uveitis. Retinal detachment has been observed by Weskamp,[33] Koyanagi,[2] Arisawa,[67] Sugimoto and Kodama[5] and Zentmayer.[17]

Secondary glaucoma has been seen by Avalos,[20b] Luo,[68] Ogawa,[4] Parker,[69] Rones[16] and Sugimoto and Kodama.[5]

Cataracta complicata has frequently been observed (by Demaria,[19] Rones,[16] Avalos,[20b] Jess[59] and myself).

An atrophic globe or phthisis bulbi may be a pathologic end result (Avalos,[20] Fialho,[44] Rones[16] and Yanes and Ferrer[21]).

DIAGNOSIS

The disease is easily diagnosed by its remarkable symptoms if the oculist is familiar with the syndrome. A nontraumatic bilateral uveitis accompanied by any or all of the symptoms described should be regarded as the Vogt-Koyanagi syndrome. The conditions from which it must be differentiated are few.

As has been said, the similarity of the syndrome to sympathetic ophthalmia is striking, but in the latter condition there is nearly always the factor of trauma.

Another closely related condition is Harada's disease, a diffuse serous choroiditis first noted by Harada in 1926 and well described by Tagami[70] in 1931 and Salus[71] in 1932. Some authors state that this disease is a

---

67. Arisawa: Nippon Ganka Zasshi **23**:700, 1919; cited by Koyanagi.[2]

68. Luo, T. H.: Uveitis Associated with Alopecia, Poliosis, Dysacousia and Vitiligo, Chinese M. J. **50**:1409-1414 (Oct.) 1936.

69. Parker, W. R.: Uveitis Associated with Alopecia, Poliosis, Vitiligo and Deafness: Report of Two Cases, Am. J. Ophth. **14**:577-581 (July) 1931.

70. Tagami, K.: Beiträge zur Kenntnis der acuten nicht eitrigen diffusen exsudativen Chorioiditis (sog. Haradasche Krankheit) aus dem Resultat des Tierversuches mit subretinalem Exsudat, Acta Soc. ophth. jap. **35**:1289-1327, 1931; German abstract, ibid., pp. 114-116.

71. Salus, R.: Harada'sche Krankheit, Klin. Monatsbl. f. Augenh. **89**:84-87 (July) 1932.

variety or stage of the Vogt-Koyanagi syndrome (Yanes and Ferrer [21]) in which the process has not extended far enough to produce serious damage.

Sugimoto and Kodama [5] described a transitional type of the condition, between Harada's disease and the Vogt-Koyanagi syndrome.

Harada's disease is characterized by an acute onset with a diffuse, yellowish, edematous opacity over the whole fundus, a general haze over the vitreous and with no evidence of involvement of the anterior segment of the eye. Detachment of the retina occurs, and perception of light may be lost. After several weeks, however, regressive changes take place, reattachment of the retina occurs, there is normal color of the fundus and normal vision is reestablished.

Uveoparotitis (Heerfordt's disease [72]) is a condition of unknown causation characterized by bilateral uveitis and parotitis, associated paresis of the cranial nerves, general symptoms and a tendency to spontaneous recovery. This condition, however, should offer no difficulty in differentiation.

PROGNOSIS

The prognosis is concerned principally with the state of the vision. Seldom, if ever, does vision return to normal. A few patients regain 20/40 or better vision. In most cases the disease results in marked impairment of sight or in total blindness. Some of the blind eyes later show atrophy or phthisis bulbi. The general health is usually unimpaired.

TREATMENT

Since the cause of the disease is unknown, specific treatment is not available. The patient is treated symptomatically, and the remedies are those used routinely in the therapy of chronic severe uveitis. Atropine if instilled early will have a beneficial effect on the inflammation besides preventing the formation of extensive posterior synechias, which may lead to complete seclusion of the pupil with resultant iris bombée and secondary glaucoma. Sodium salicylate in large doses (6 to 8 Gm. per day) has been given empirically, as in the treatment of sympathetic ophthalmia. Potassium iodide, a drug used for obscure chronic conditions, has also been administered. Subconjunctival injections of 2.5 per cent solution of sodium chloride were given by Kuhlmann [73] but proved of no benefit.

---

72. Heerfordt, C. F.: Ueber eine "Febris uveo-parotidea subchronica" an der Glandula parotes und der Uvea des Auges lokalisiert und häufig mit Paresen cerebrospinaler Nerven kompliziert, Arch. f. Ophth. **70**:254-273, 1908.

73. Kuhlmann, O.: Dysacusis, alopecia y poliosis en uveitis grave no traumatica, Arch. Soc. méd. de Valparaiso **12**:817-819, 1929.

Fever therapy has been used frequently, either in the form of intramuscular injections of milk or in the form of intravenous injections of typhoid vaccine. In the first instance, 5 cc. doses of milk previously boiled for four minutes are injected deep into the gluteal region. In the latter instance, the dose may begin at 10,000,000 organisms and may be increased by 10,000,000 in successive injections. Each injection is given twenty-four hours after the reaction to the preceding one has subsided.

Following the plan of Verhoeff [74] for treatment of sympathetic ophthalmia, Luo [68] treated a patient by injecting into the buttocks 20,000 units of diphtheria antitoxin daily for a week and then once more after an interval of seven days. No beneficial effects were secured.

Whenever there was a positive serologic reaction, antisyphilitic treatment was given with neoarsphenamine, mercury cyanide and bismuth. Even in cases in which the reaction was negative this treatment was used empirically by Kuhlmann,[73] as in cases of sympathetic ophthalmia.

Injections of tuberculin have been used. Nakamura [75] reported good results in the treatment of exudative uveitis and sympathetic ophthalmia by means of AO tuberculin. He treated a woman aged 28 who according to his description was suffering from the Vogt-Koyanagi syndrome. He administered nine injections of AO no. 1 at weekly intervals and claimed satisfactory results.

Rones [16] treated one of his patients, a boy aged 10 who gave a positive reaction to uveal pigment, with injections of uveal pigment. Five injections were given, but the results were not satisfactory.

Complications should be treated as indicated. If an iris bombée is present, Fuchs's transfixion operation should be performed to relieve any secondary glaucoma. This operation was performed by Luo.[68] A cyclodialysis or Elliot's trephine operation may be performed. Both procedures were used in one of Parker's [69] cases (1931). Iridectomy was performed by Goldstein in Wexler's [66] case without beneficial results.

For the initial pain sedatives such as acetylsalicylic acid and aminopyrine are administered. Large doses of sodium salicylate are also useful.

The patient's general condition should receive attention. Nourishing food, vitamin concentrates, tonics and hematinics may be given.

In general, the results of treatment are disappointing, although some of the therapeutic measures have proved beneficial.

---

74. Verhoeff, F. H.: An Effective Treatment for Sympathetic Uveitis, Arch. Ophth. **56**:28-41 (Jan.) 1927.

75. Nakamura, B.: Zur Kenntnis der erfolgreichen Behandlung der exudativen Uveitis sowie der sympatischen Ophthalmie mittels "AO," Klin. Monatsbl. f. Augenh. **89**:43-51 (July) 1932.

TABLE 1.—*Summary of Findings in All Cases Other Than Those Tabulated by Koyanagi in 1929* *

Author and Year	Age and Sex	Symptoms; Initial Visual Disturbance	Ocular Findings	Associated Symptoms and Time of Appearance: Dysacousia	Associated Symptoms and Time of Appearance: Poliosis and Alopecia	Associated Symptoms and Time of Appearance: Vitiligo	Wassermann, Tuberculin, Uveal Pigment Test	Vision
1. Gilbert [14] (1910)†	36 ♂	?	Deposits on Descemet's membrane; hyphemia; optic neuritis and iritis	?	Poliosis at onset	Vitiligo at onset	?	Reduced vision (?)
2. Erdmann [15] (1911)	44 ♂	?	Opacities in vitreous; edematous retina; depigmentation and pigment collections	?	Poliosis 2 yr. before onset	Vitiligo 2 yr. before onset	Wassermann, negative; tuberculin, negative	Right eye, 5/36; left eye, 5/12
3. Demaria [19] (1917)	18 ♂	Slight pain in eyes	Ciliary injection; turbid aqueous; atrophic iris; posterior synechia; cataractous lenses; fundi not visible	?	Poliosis at onset	Vitiligo 3 yr. before onset	Wassermann, negative; tuberculin, negative	Light perception, both eyes
4. Demaria [19] (1917)	39 ♀	.....	Ciliary injection; discolored atrophic irises; seclusion of pupils; exudate in pupil; complicated cataract; left eye affected first; right affected 4½ years later	No	Poliosis in left eye 1 yr. before onset	Vitiligo in left eye 1 yr. before onset	?	Right eye, light perception; left eye, blind
5. Baldino [28] (1920)	25 ♂	Pain in supraorbital regions at onset and during illness; intermittent pain in eyes	Iritis in both eyes; pupillary occlusion and seclusion; membranous exudate in pupil; atrophic iris; shallow anterior chamber	No	Poliosis 1 yr. after onset	Vitiligo 1 yr. after onset	Wassermann, positive	Perception of hand movements, both eyes
6. Wexler [66] (1928)	45 ♀	No pain	Atrophic iris; deposits on Descemet's membrane; iris bombée; exudate on pupil; posterior synechia; fundi not visible	No	Poliosis, time ?	Vitiligo 15 yr. before onset	Wassermann, negative	Right eye, 20/200; left eye, perception of hand movements
7. Kuhlmann [73] (1929)	30 ♀	Headache; vertigo; general pain	Deposits on Descemet's membrane; posterior synechia; opacities in vitreous; dirty gray fundus reflex; disks blurred	Tinnitus, time ?	Poliosis 3 mo. after onset	No	Wassermann, negative	Light perception, both eyes
8. Gilbert [58] (1930)‡	52 ♀	?	Iridocyclitis	No	No	Vitiligo, time ?	Wassermann, negative	?
9. Gilbert [58] (1930)‡	Climacteric ? ♀	?	Bilateral uveitis	No	No	Vitiligo, time ?	Wassermann, negative	?
10. Fialho [44] (1931)	13 ♂	?	Severe bilateral iridocyclochoroiditis	?	Poliosis and alopecia 4 mo. after onset	?	Wassermann, negative; tuberculin, negative	?
11. Parker [69] (1931)	18 ♂	Pain in both eyes	Edematous disk; loss of retinal transparency; edema of macula; posterior synechia; punctate keratitis; deposits on Descemet's membrane; exudate on pupil	No	Poliosis 10 wk. after onset; alopecia 11 wk. after onset	Vitiligo 6 wk. after onset	Wassermann, blood and spinal fluid, negative; tuberculin, negative	Counting of fingers at 3 feet (91 cm.), both eyes

of macula; posterior synechia; punctate keratitis; deposits on Descemet's membrane; exudate on pupil				after onset; alopecia 11 wk. after onset		after onset	spinal fluid, negative; tuberculin, negative	Counting of fingers at 3 feet (91 cm.), both eyes
12. Parker [69] (1931)	25 ♀	Sore throat; headache; pain in eyes	Deposits on Descemet's membrane; posterior synechia; exudate on pupil; iris vascular and swollen; fundi not visible	Tinnitus 2 wk. after onset	Poliosis and alopecia 3 mo. after onset	No	Wassermann, blood and spinal fluid, negative; tuberculin, negative; uveal pigment, negative	Perception of hand movements, both eyes
13. Weskamp [32] (1932)	34 ♂	Disease occurred after shock of a fall; headache	Ciliary injection; corneas opalescent; iris blurred; opacities in vitreous; deposits on Descemet's membrane; cells in aqueous; retinal detachment	Tinnitus; deafness from onset	Poliosis and alopecia 2 mo. after onset	No	?	Light perception, both eyes
14. Rones [16] (1932)	10 ♂	No report	Deposits on Descemet's membrane; complete posterior synechia; no fundus reflex	No	Poliosis 2 mo. after onset	Vitiligo 1 mo. after onset	Wassermann, negative; tuberculin, negative; uveal pigment, positive	Blind
15. Rones [16] (1932)	28 ♀	Severe pain in eyes, radiating to head	Deposits on Descemet's membrane; iris congested and vascularized; exudates on pupil; posterior synechia; cataractous lenses; fundi not visible	Deaf, right ear, 4 mo. after onset	Poliosis and alopecia 4 mo. after onset	No	Wassermann, negative; tuberculin, negative; uveal pigment, negative	Blind (?)
16. Avalos [20a] (1932)	42 ♀	Headache; vertigo; vomiting	Iridocyclitis in both eyes; seclusion of pupils; complicated cataract	No	Poliosis 2 mo. after onset	No	Wassermann, blood weakly positive, spinal fluid negative	Blind
17. Nakamura [75] (1932)	28 ♀	Headache; pain in eyes	Deposits on Descemet's membrane; atrophy of choroid; depigmentation and detachment of retina	Tinnitus; deafness 15 days after onset	Alopecia 10 wk. after onset	No	Tuberculin, positive; Wassermann, ?	Counting of fingers at 6 cm.
18. Avalos [20b] (1932)	34 ♀	Earache; headache; discomfort in eyes	Seclusion of pupils; cataractous lenses; secondary glaucoma	Tinnitus; deafness 15 days after onset	Poliosis and alopecia 4 mo. after onset	Vitiligo 4 mo. after onset	Wassermann, weakly positive	Blind
19. Jess [59] (1932)§	13 ♀	?	Iritis; iris bombée; deposits on Descemet's membrane and lens; posterior synechia; total cataract, both lenses	No	Poliosis 4 mo. after onset	Vitiligo, time ?	Tuberculin, negative; Wassermann, ?	Light perception, both eyes
20. Krasnoff [60] (1935)‖	42 ♂	?	Cicatrized trachoma; bilateral uveitis	No report	Poliosis, time ?	Vitiligo, time ?	Wassermann, positive; tuberculin, positive	Much reduced ?
21. Davis, W. S.: Arch. Ophth. **14**: 239 (Aug.) 1935	31 ♂	Headache and lethargy	Ciliary injection; vascularization of cornea; atrophic iris; deposits on Descemet's membrane and lens; posterior synechia; faint fundus reflex; no details	Deafness 1 mo. after onset	Poliosis and alopecia 6 wk. after onset	No	Tuberculin, negative; Wassermann, ?	Light perception, both eyes
22. Anastasi, G.: Ann. di ottal. e clin. ocul. **64**: 59 (Jan.) 1936	16 ♂	Acute articular rheumatism	Deposits on Descemet's membrane; atrophic iris; posterior synechia; seclusion of pupils; iris bombée; exudate in pupil	No	Poliosis, time ?	Vitiligo, time ?	Wassermann, negative; tuberculin, negative	Right eye, counting of fingers at 2 mm.; left eye, 1/10

TABLE 1.—*Summary of Findings in All Cases Other Than Those Tabulated by Koyanagi in 1929*—Continued*

Author and Year	Age and Sex	Symptoms; Initial Visual Disturbance	Ocular Findings	Associated Symptoms and Time of Appearance: Dysacousia	Associated Symptoms and Time of Appearance: Poliosis and Alopecia	Associated Symptoms and Time of Appearance: Vitiligo	Wassermann, Tuberculin, Uveal Pigment Test	Vision
23. Luo [68] (1936)	31 ♂	Pain over vertex of head and in eyes	Deposits on Descemet's membrane; shallow anterior chambers; flare in aqueous and seclusion of pupil; iris bombée; no fundus reflex; secondary glaucoma	Tinnitus; deafness 4 wk. after onset	Poliosis and alopecia 3 wk. after onset	Vitiligo, time ?	Wassermann, negative; tuberculin, negative	Perception of hand movements, both eyes
24. Avalos [42] (1936)	27 ♀	Pain in eyes	Uveitis; seclusion of pupils	Deafness, time ?	Poliosis and alopecia, time ?	No	No	Blind
25. Yanes and Ferrer [21] (1938)	46 ♀	Pain in eyes; headache; vertigo; malaise	Ciliary injection; posterior synechia; turbid media; fundi not visible; later, phthisis bulbi	Dysacousia, time ?	Poliosis and alopecia 2 mo. after onset	No	Wassermann, negative; tuberculin, weakly positive	Slight light perception, both eyes
26. Yanes and Ferrer [21] (1938)	35 ♀	Vomiting	Uveitis; neuroretinitis; opacities in vitreous	Left ear, deafness at onset	Poliosis and alopecia 2 mo. after onset	Vitiligo 2 mo. after onset	Meinicke, twice negative; tuberculin, negative	20/30, both eyes
27. Babel [3] (1939)¶	52 ♀	Irritation and pain both eyes	Ciliary injection; deposits on Descemet's membrane; posterior synechia; pigment grains on lens; folds in Descemet's membrane; fundi not visible; right eye affected first	No	Poliosis 1 mo. before iritis	Vitiligo 12 yr. before onset	Wassermann, Vernes and Meinicke, negative	Right eye, 5/30; left eye, 5/15
28. Zentmayer [17] (1941)	30 ♀	Headache; feeling of pressure in eyes	2/11/39: neuroretinitis, both eyes, retinal detachment; 6/14/39: pigment and fibrin deposits on Descemet's membrane and lens; posterior synechia; opacities in vitreous; pale disk; atrophy of choroid; free pigment in periphery of fundus	Totally deaf at onset	Poliosis, time ?	Vitiligo, time ?	Wassermann and tuberculin, negative	1⅛/60, both eyes
29. Carrasquillo (1941)#	36 ♂	Malaise; headache; nausea; vomiting; vertigo	Ciliary injection; punctate keratitis; deposits on Descemet's membrane; flare in aqueous; posterior synechia; pigment deposits on lens; cataractous lenses; opacities in vitreous; faint yellowish fundus reflex; details not visible	Tinnitus; deafness 6 wk. after onset	Poliosis and alopecia 3 mo. after onset	Vitiligo 3½ mo. after onset	Wassermann and Kahn, blood 3 plus, spinal fluid 4 plus; tuberculin strongly positive; uveal pigment, negative	Counting of fingers: right eye at 3 ft. (91 cm.); left eye, at 2 ft. (60 cm.)

* In addition to these cases, 9 others, occurring in Japan, have been cited by Luo.[68] Descriptions are not available.
† The patient also had complete suppression of sexual function.
‡ The patient had the syndrome at the climacteric.
§ The patient also showed adiposogenital dystrophy.
‖ The patient also showed hypofunction of the sexual glands, adrenal cortex and posterior lobe of the hypophysis.
¶ A diving goiter was also present.
# The patient also showed evidence of slight thyroid hyperactivity.

REPORT OF A CASE

S. A., a white Puerto Rican laborer aged 36, came to the dispensary of the Municipal Hospital at Arecibo, Puerto Rico on Jan. 15, 1940 complaining of failing vision and pain in both eyes. He was referred to my office at Utuado.

History.—There was no family history of symptoms of the Vogt-Koyanagi syndrome. The parents were not consanguineous. The patient's six children were in good health.

During childhood the patient had measles, chickenpox and mumps. He lived in a malaria district and had had several attacks of this disease. At the age of 16 he had gonorrhea, but without complications. In 1934 he had an ulceration of the left nasal ala. Examination of the blood at the Presbyterian Hospital, San Juan, Puerto Rico, showed a positive reaction for syphilis. The patient was given six intravenous injections of neoarsphenamine at weekly intervals with excellent results. No further treatment was given. He smoked very little and seldom indulged in alcoholic drinks.

The first symptoms of the present illness had appeared six months before, at which time there was blurring of vision and pain in both eyes and over both supraorbital regions. The eyes became red and painful, with lacrimation and photophobia. Ocular movements were painful. The vision rapidly became so poor that the patient had to be guided. A month after the onset he had an attack of dizziness and fell. There was subsequent vomiting, and the patient was unable to raise his head. He remained in bed for three days. At no time did he lose consciousness. Six weeks after the onset of the disease the ears were affected. Tinnitus developed, and noises caused earache and nervous disturbances. The patient lived near a railroad, and the sound of locomotive whistles caused him intense suffering. His hearing soon began to fail, and at the time of writing he is partially deaf. About three months after the initial symptoms, the patient was told by relatives that the hair of his head and eyebrows was turning gray. Shortly afterward white patches appeared on the skin of the forehead, and later similar patches developed on the hands, shoulders, chest and buttocks. The patient did not notice any loss of hair. He complained of weakness, but did not believe that there had been fever at any time. The pain in the eyes decreased and then increased again at intervals of three or four weeks. At the time of the examination the patient was uncomfortable but had no actual pain. He complained of very poor vision.

Examination.—The patient was a dark, undernourished, weak-looking man who appeared older than the stated age. He had been led to the office by a guide. The hair of the head was jet black, but there were patches and locks of canities in diffuse form. There was a patch of gray hair at the hair line in the frontoparietal region on each side (fig. 1). In these areas the hair was sparse. There was generalized thinning of the hair over the entire head. Two other areas of sparse gray hair were seen, one on the temporal half of each eyebrow (fig. 1). Both lower lids showed a few white cilia, these being most evident on the nasal side on the left (fig. 1). Locks of gray hair were present in the occipital region (fig. 2).

The hair of other regions of the body showed no canities except that in the gluteal folds there were a few white hairs (fig. 3).

The gray patches of the head and of the eyebrows were located in areas of discolored skin. Other white areas involved the temples, forehead, cheeks, shoulders, chest, hands, back and lumbar region, and an extensive symmetric butterfly-like patch covered almost the entire gluteal region (figs. 1, 2 and 3).

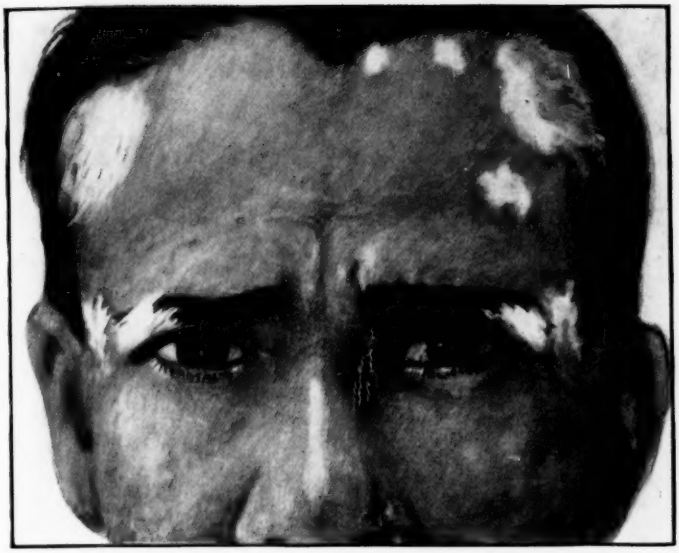
It was noticed that the patient was partially deaf, and it was necessary to address him loudly. No otologic examination was made at this time.

The patient had a vacant expression. There was some bilateral blepharochalasis. No proptosis was evident. Tiny areas of discoloration were noted in the margin of each lower lid nasally. Five white cilia were observed in the left lower lid nasally and three in the right in the same location (fig. 4).

The visual acuity was counting of fingers at 3 feet (90 cm.) in the right and at 2 feet (60 cm.) in the left. The intraocular tension (Schiøtz) was 15 in each eye. The ocular rotations were normal. There was no pathologic condition of the lacrimal apparatus. The palpebral conjunctivas showed no abnormalities, but the bulbar showed slight redness. There was some ciliary injection in each eye. The corneas were 12 mm. in diameter. Examination with a binocular loupe and oblique illumination showed no pathologic change except numerous deposits on Descemet's membrane in both eyes. They were arranged in typical triangular fashion. Both anterior chambers were deep. The irises had a muddy, discolored appearance, and their markings were blurred (fig. 4). Whitish atrophic areas were scattered throughout both irises. In the left iris a large crescent-shaped area extended from 6 to 9 o'clock, including almost the whole outer circle. A similar but narrower band was seen in the right iris from 3 to 7 o'clock. The pupillary margins were irregular and ragged in appearance. The pupils were approximately 3.5 mm. in the longest diameter. Extensive posterior synechias were present in both eyes, almost completely encircling the pupillary edges. Only small segments from 10 to 11 : 30 in each eye were free from adhesions. As the result of complete atrophy of the iris tissue, there were two indentations in the ciliary margins, at 3 o'clock in the right eye and at 2 o'clock in the left (fig. 4). Fragments of iris pigment epithelium were attached to the surface of the lens in the vicinity of the pupillary margin, nasally in the right and temporally in the left. Both lenses showed diffuse, pearl white opacities.

One drop of 1 per cent atropine sulfate was instilled in each eye. An hour later there was some dilatation of the free segment of the iris in both eyes and ophthalmoscopic examination was attempted. Only a small area of faint yellowish fundus reflex could be seen in each eye. Thick floating opacities were observed in the vitreous.

Slit lamp examination of the right eye disclosed dilatation of the anterior ciliary vessels. A few minutes punctate equally spaced areas were noticed in the center of the corneal surface. Numerous precipitates of lardaceous type were seen on Descemet's membrane arranged in a triangular form. Pigment granules were intermingled. Some aqueous flare was noted. The iris had a muddy appearance throughout, and its surface markings were obscured. Atrophic areas were scattered throughout. A crescent-shaped zone of atrophy extended from 3 to 7 o'clock,



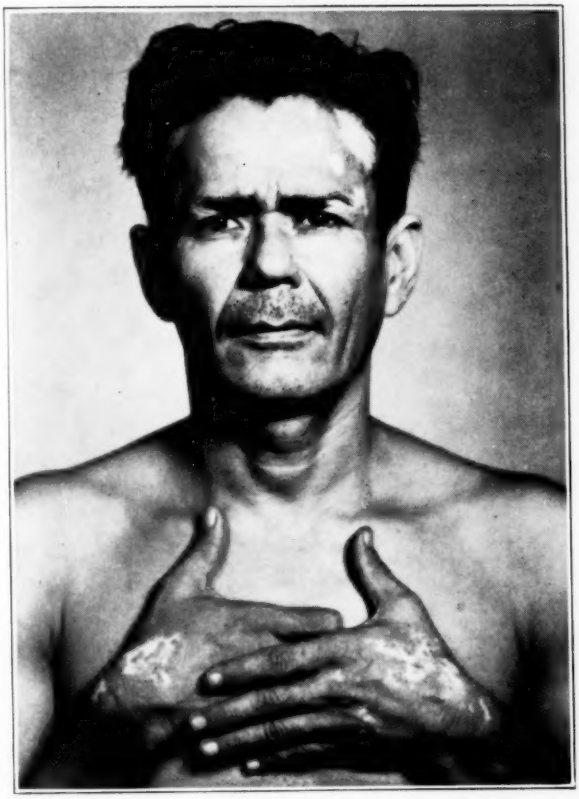


Fig. 1.—Alopecia, poliosis and patches of vitiligo. Note the symmetric distribution of the lesions.

covering about half of the outer circle. An atrophic spot in the iris tissue produced a transparent indentation of the ciliary margin at 3 o'clock. The margin of the pupil was ragged. Extensive adhesions to the anterior capsule of the lens extended around almost the whole circumference of the pupillary opening. Only a small segment from 10 to 11:30 o'clock remained free. Fragments of iris pigment epithelium and pigment dust were noticed on the anterior capsule of the lens, which showed diffuse cataractous changes. In the left eye the picture was identical.

A diagnosis of the Vogt-Koyanagi syndrome was made.

The patient was hospitalized at Clinica San Miquel, a small privately owned institution, where general medical examination revealed nothing other than exten-

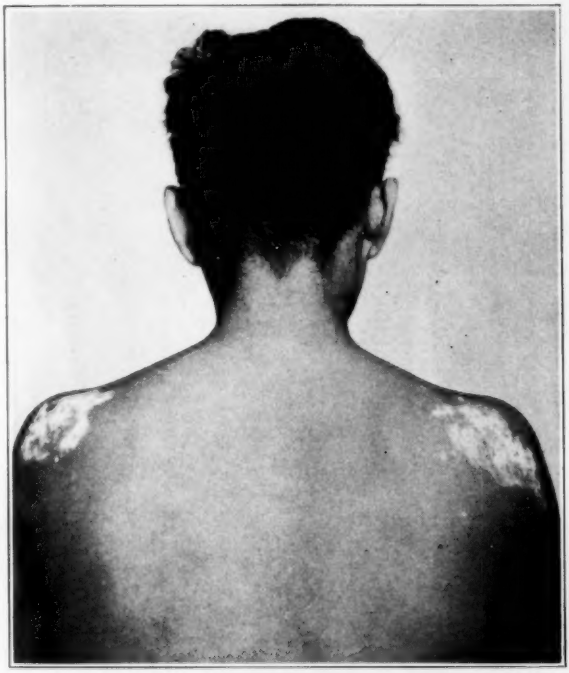


Fig. 2.—Locks of canities in the occipital region. Note the symmetric patches of vitiligo on the shoulders.

sive pyorrhea alveolaris. The report of examination of the blood was as follows: total erythrocytes, 3,400,000; smear, normal but rather pale cells; hemoglobin content, 60 per cent; total leukocytes, 6,000; polymorphonuclear neutrophils, 70 per cent; lymphocytes, 26 per cent; eosinophils, 4 per cent. Examination of the feces revealed the presence of ova of Uncinaria and Tricocephalus. Urinalysis gave negative results. The Wassermann reaction of the serum was negative, but the reaction of the spinal fluid was strongly positive (4 plus).

Treatment.—A 1 per cent solution of atropine sulfate was instilled in each eye three times daily. Hot compresses of 2 per cent boric acid solution were applied

three times daily. Intramuscular injections of whole milk were given every three days, with consequent good febrile reaction. Intravenous administration of neoarsphenamine (0.6 Gm.) was begun, but only two injections were given because the patient left the hospital after two weeks. For the general anemic condition he was given iron sulfate by mouth, vitamins and a nourishing diet. His general health was greatly improved when he left the hospital.

Later Course.—The patient did not return until March 20, 1941, at which time he was admitted to the Presbyterian Hospital, San Juan, Puerto Rico, for observa-

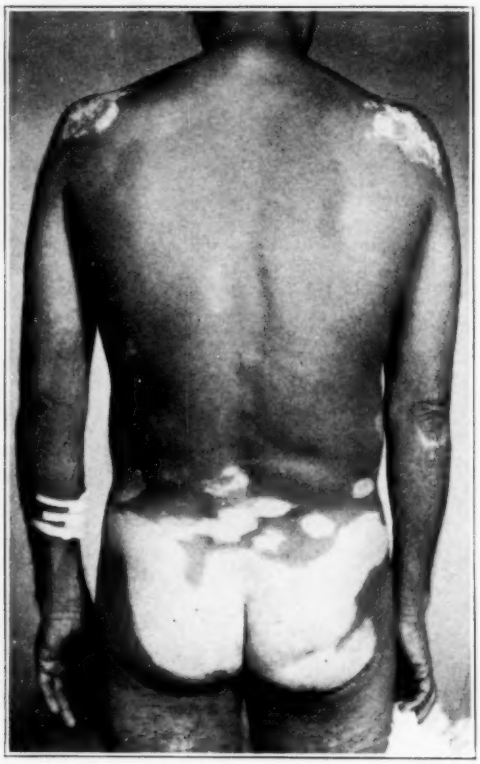


Fig. 3.—Fringelike patches of vitiligo on the shoulders and extensive butterfly-like area involving the buttocks. A few white hairs are visible in the gluteal folds. Note the symmetry of the lesions of vitiligo.

tion and further study. A complete medical examination was made, as well as special examinations of the ears, nose, throat and skin and careful study of the ocular condition.

The general examination revealed no positive findings other than the presence of several carious teeth and severe pyorrhea alveolaris. The clinical chart showed marked variation in the pulse rate, which was usually rapid and frequently reached 110.

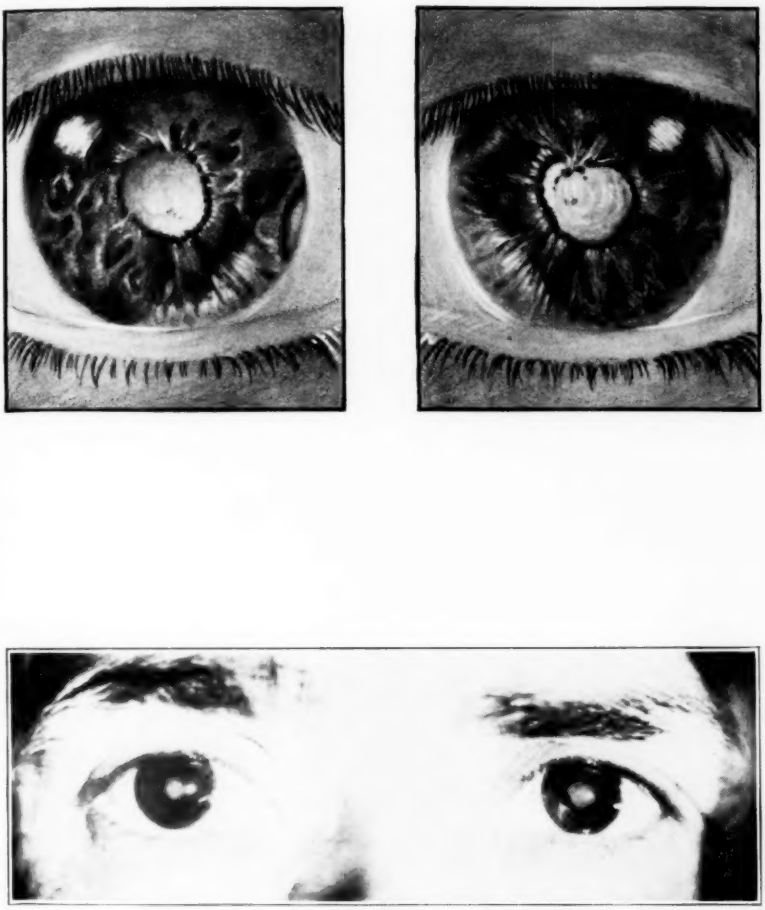


Fig. 4.—Atrophy of the irises, ragged pupillary margins, almost complete annular synechias and cataractous lenses. Note the few white cilia on both lower lids.

The ocular findings were essentially the same as those of Jan. 17, 1940, except that the eyes were quiet. The precipitates on Descemet's membrane and the flare in the aqueous had disappeared. The visual acuity had improved and was now 20/300 in the right eye and 20/400 in the left. A partial view of the fundi was now possible through the less clouded media. A yellowish fundus reflex was

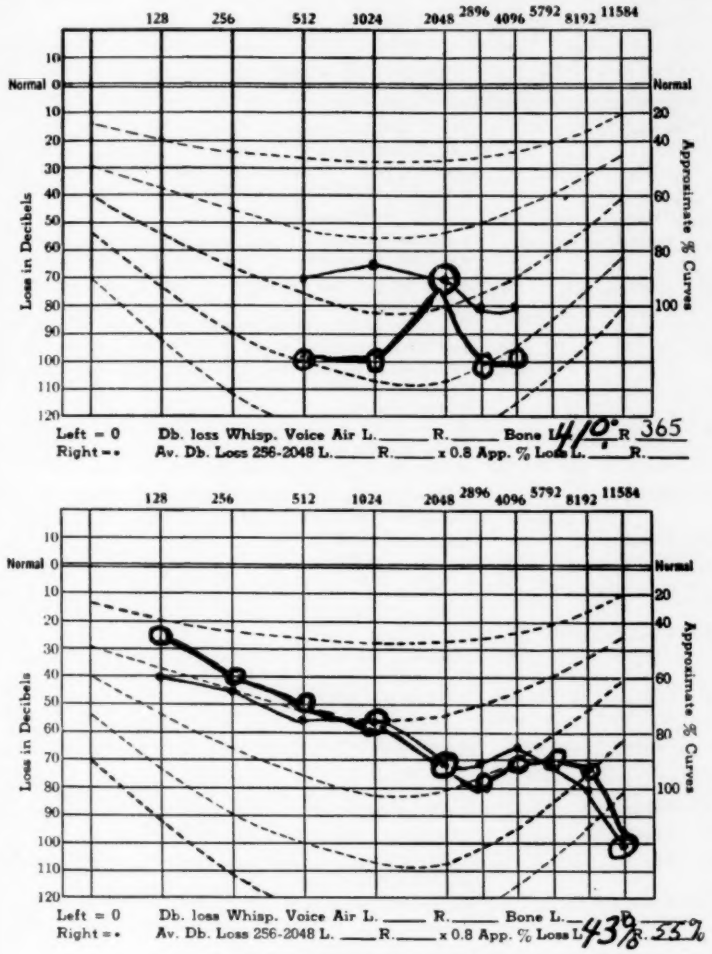

128 256 512 1024 2048 2896 4096 5792 8192 11584
Normal 0
Loss in Decibels
Approximate % Curves
Left = 0
Right = •
Db. loss Whisp. Voice Air L. R. Bone L. R
Av. Db. Loss 256-2048 L. R. x 0.8 App. % Loss L. R.
410 R 365
128 256 512 1024 2048 2896 4096 5792 8192 11584
Normal 0
Loss in Decibels
Approximate % Curves
Left = 0
Right = •
Db. loss Whisp. Voice Air L. R. Bone L.
Av. Db. Loss 256-2048 L. R. x 0.8 App. % Loss L
43 5/8 55%

Fig. 5.—Audiometric graphs.

observed in the right eye. The vessels, vaguely seen, appeared attenuated. The appearance gave the impression of choroidal atrophy in both fundi.

The otologist's report was as follows: "Examination of the ears, nose and throat gives essentially negative results. There are no congenital or acquired malformations of the ear. The sound-conducting apparatus is intact. The functional tests show the characteristic sign of nerve deafness. Bone conduction is reduced as

well as air conduction, and there is loss of hearing for the high tones. The changes responsible for the deafness have taken place in the auditory perceptive mechanism and have a great similarity to those found in senile deafness." The audiometric graphs are shown in figure 5.

The cutaneous condition was similar to that seen at the first examination, although some of the patches, particularly those on the chest, had disappeared. The dermatologist's diagnosis was vitiligo.

TABLE 2.—*Results of Laboratory Studies*

3/22/41	Urine.....	Color, yellow; character, turbid; reaction, slightly acid; specific gravity, 1.026; reaction for albumin, negative; reaction for sugar, negative; white blood cells, occult; epithelial cells, few; bacteria, some; crystals, calcium oxalate
3/22/41	Feces.....	Ova of hookworm and whipworm
4/30/41	Urine.....	Phenolsulfonphthalein test: first specimen, 60 per cent; second specimen, 20 per cent; total, 80 per cent; first specimen at 8:50
3/21/41	Blood.....	Sugar, 93 mg. per 100 cc.; creatinine, 1.6 mg. per 100 cc.; uric acid, 4 mg. per 100 cc.; nonprotein nitrogen, 40 mg. per 100 cc.; urea, 10 mg. per 100 cc.; chlorides, 456 mg. per 100 cc.
3/22/41	Blood.....	Red cells, 3,970,000; white cells, 6,700; hemoglobin content, 68 per cent; color index, 8; clotting time, 4 minutes; bleeding time, 3½ minutes; Schilling count, 16 eosinophils and 1 monocyte
3/22/41	Blood.....	Mean corpuscular volume, 88 cu. μ; mean corpuscular hemoglobin concentration, 26 per cent; mean corpuscular hemoglobin, 22 γ; volume index, 0.9
3/22/41	Blood.....	Sedimentation rate after 1 hour, 5.1 mm.; volume of packed red cells; sedimentation rate corrected, 2.9 mm.
3/22/41	Blood.....	Kahn test, 3-3-3
3/27/41	Blood.....	Kahn test, 3-3-3
3/26/41	Spinal fluid.....	White blood cells, 3 per cu. mm.; sugar, 60.6 mg. per 100 cc.; reaction for globulin, negative; chlorides, 750.7 mg. per 100 cc.
4/21/41	Spinal fluid.....	Wassermann test: 0.2 cc., ++++; 0.4 cc., +++; 0.6 cc., negative; 0.8 cc., negative; 1 cc., negative; gold curve, 1111000000
4/ 1/41	Culture of nasal secretion	Micrococcus catarrhalis
4/ 1/41	Culture of material from throat	M. catarrhalis; gram-negative bacili; corynebacteria
4/25/41	Culture of material from throat	Culture (blood agar plate) Staphylococcus aureus; M. catarrhalis; streptococci; corynebacteria; gram-negative bacilli
3/28/41	Basal rate.....	+11
3/28/41	Blood.....	Kahn, Kline and Kolmer tests, made by department of health laboratory, positive
4/ 3/41	Blood culture.....	No growth in 10 days

The results of laboratory studies are shown in table 2.

A uveal pigment test was performed intracutaneously and no reaction noted. After two weeks a specimen of skin for biopsy was sent to Dr. Alan C. Woods at the Johns Hopkins Hospital. The report was negative. The reaction to a tuberculin test with purified protein derivative was 3 plus in the first dilution.

Roentgen examination of the chest, skull and sinuses gave negative results except to disclose a marked opacity of the left maxillary sinus.

Microscopic examination of the shafts of some of the white hairs revealed no increase in air content. Pigment was absent in them except for a few granules between the cells.

Intracutaneous tests for allergy were performed, the following extracts being used: *

Milk (cow's)	1-10	Bermuda grass	0.02
Rice	0.05	Spiny amaranth	0.05
Kidney bean	0.05	Acacia	0.02
Navy bean	0.05	Chenopodium album	0.05
Chocolate	0.05	Sorghum vulgare	0.05
Codfish	0.05	Zea mays	0.05
Whitefish	0.05	Plantago major	0.05
Pork	0.05	House dust	0.15
Beef	0.05	Cottonseed	0.05
Egg	0.03	Kapok	0.05
Corn	0.05	Guano	0.03
Potato	0.05	Hormodendrum	0.05
Sweet potato	0.05	Alternaria	0.10
Banana	0.05	Penicillium	0.10
Orange	1-5	Aspergillus	0.05
		Fusarium	0.10
		Mucor	0.05

* For milk and orange the figures refer to concentration of the dilution; otherwise they express the amount of nitrogen in milligrams per cubic centimeter of the extract.

An intracutaneous test with a mixture of Micrococcus catarrhalis, Bacillus influenzae, Streptococcus (hemolytic and viridans), Staphylococcus albus, Staphylococcus aureus and Pneumococcus types I, II and III (200,000,000 organisms per cubic centimeter) showed no reaction in twenty-four or forty-eight hours.

All the tests performed gave negative results except that with milk, which produced a moderate reaction considered to be of no clinical significance.

Treatment was the same as during the first period of hospitalization but was more intensive. In addition, potassium iodide (5 grains [0.3 Gm.] by mouth three times a day) and sodium salicylate (1½ Gm. four times daily) were administered. Injections of typhoid vaccine were given as described in the section dealing with methods of treatment. The patient received six intravenous injections (0.6 Gm.) of neoarsphenamine and a bismuth preparation given intramuscularly. The general condition was treated as before.

The patient's general health improved considerably after treatment, and he gained 12 pounds (5 Kg.). The condition of the eyes, ears, skin and hair remained essentially unchanged.

SUMMARY AND CONCLUSIONS

A thorough review of the literature dealing with the Vogt-Koyanagi syndrome is presented, together with a discussion of the theories concerning its origin and pathogenesis. The similarity of this condition to other pathologic states, such as sympathetic ophthalmia and Harada's

disease, is considered. The symptoms of the disease are described, and different methods of treatment are discussed.

A typical case of the Vogt-Koyanagi syndrome is reported in detail. The patient exhibited all the features characteristic of the syndrome. Serologic and tuberculin tests gave positive reactions. The basal metabolic rate was + 11. The pulse rate was variable, often reaching 110.

Twenty-nine cases, the reports of which I have carefully studied, are tabulated to provide condensed information regarding the incidence of the various symptoms and the similarity of the cases.

Although the serologic and the tuberculin tests gave positive reactions, I do not regard either syphilis or tuberculosis the sole causative agent.

From a review of the literature and from personal study of a case, I believe that a neuropathic factor of sympathetic activity is operative in the production of the Vogt-Koyanagi syndrome. However, the manner in which this factor is activated is still unknown. Further observations and studies are necessary to clarify the problem.

Post Office Box 128.

The patient reported on was given free hospitalization at Clinica San Miguel, Utuado, and at the Presbyterian Hospital, San Juan, Puerto Rico. Drs. J. H. Font, A. Navas Torres, D. Santiago Stevenson, A. M. Marchand and J. Toro Hernandez studied the case. Mr. R. Rios Vega, of the Instituto Oftalmico de Puerto Rico, prepared most of the illustrations.

CORTICAL REPRESENTATION OF THE MACULA LUTEA

WITH SPECIAL REFERENCE TO THE THEORY OF BILATERAL REPRESENTATION

TRACY J. PUTNAM, M.D.
NEW YORK
AND
SUMNER LIEBMAN, M.D.
BOSTON

INTRODUCTION

The purpose of this paper is to present a review of the origin and development of the conception of the cortical representation of the macula, with especial reference to the theory of bilateral representation of both halves of the macula. A large number of observations bearing on the subject have been recorded, and more are constantly being reported, often without adequate survey of what has gone before. It appears somewhat unlikely that further new cases will radically alter the broad outlines of the situation. The type of study which seems at present most likely to illuminate the question is a critical and unprejudiced evaluation of the data now available.

1. *The Definition of the Macula and of the Fovea.*—Among perimetrists, there appears to be a tendency to ascribe a somewhat elastic value to the size of the macula. Thus, Bunge suggested that it subtends 7 degrees; Wilbrand (1890), that it subtends 10 degrees. Later writers on the subject usually overlook the problem entirely.

The fundamental question is obviously an anatomic one. There is a gradual increase of the density of visual elements from the periphery toward the center. In the region of the fixation point, there are two specialized structures visible to the naked eye; the macula lutea, measuring on an average 1.7 mm., and the fovea centralis, measuring about 0.3 mm. (Dimmer). Assuming an average diameter of 24 mm. for the curvature of the retina, the average arc of the macula would be about 9 degrees and that of the fovea about 2 degrees. A more intensive study

From the Neurological Institute of New York, the Department of Neurology of Columbia University College of Physicians and Surgeons, the Massachusetts Eye and Ear Infirmary and the Department of Ophthalmology of Harvard Medical School.

of the density of visual elements has been made by Zwanenburg, whose findings are summarized in figure 1. (See also Polyak.)

In practically none of the reported cases of "macular sparing" does the area of preserved central vision correspond with the expected projection of the macula. As defined anatomically in most instances, the preserved central vision subtends only a few degrees. If the entire macula is actually represented in both occipital lobes, there should be approximately as much diminution of visual acuity on the unaffected side as there is retained vision on the hemianopic side after a unilateral lesion destroying a portion of the macular fibers (Wilbrand).

The problem is not solved by shifting it to the bilateral representation of the fovea centralis, for in some reported instances the spared portion of an incomplete hemianopia is far larger. In other instances still it

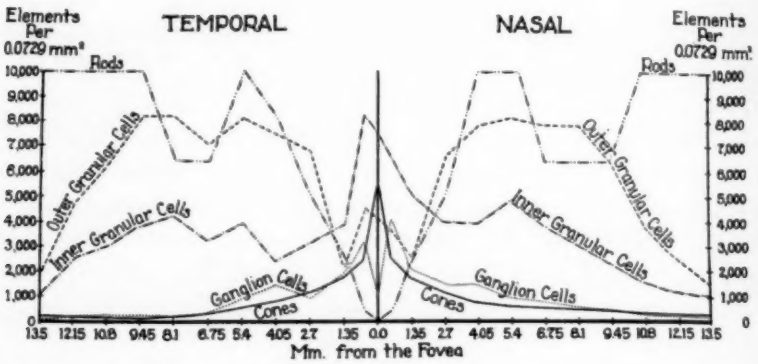


Fig. 1.—The distribution of cells of different types in the human retina. (After Zwanenburg.)

extends some distance up and down the vertical dividing line, as was pointed out by Wilbrand (1890).

2. *The Difficulties of Perimetry.*—Most studies of the central visual system rest on the results of perimetry. (Those of Brouwer's school, and a few others, are exceptions.) But perimetry is a difficult art, in which the data must pass through the subjective judgment first of the patient, then of the examiner. Many patients suffering from cerebral lesions are in poor condition, tired, confused and even aphasic or demented. Some examiners are impatient or prejudiced. The most valuable reports are those of studies in which quantitative perimetry has been employed, by means of the Bjerrum screen, the Ferree-Rand arc perimeter or Lloyd's stereocampimeter, several sizes of test object having been used. The concentric determinations then confirm each other and make it possible to distinguish between an absolute and a relative defect. Perimetry with fingers, lights or unstandardized test objects has a limited value.

A particular stumbling block in the study of hemianopia is the question of fixation. It sometimes appears that a patient suffering from a complete hemianopia tends to displace the fixation point into the intact side. According to Adler and Fliegelman fixation is a relative term in all cases; it is normal for attention to wander rapidly over an area of variable size. Hemianopic patients often displace the fixation point into the remaining field (Fuchs).

3. *Limitations of Anatomic Verification.*—Cases in which there has been no autopsy can be admitted in evidence only provisionally. Localization of tumors and projectiles is most uncertain. The study of surgical extirpations has certain advantages but suffers from the following limitations:

A. Disease processes such as neoplasms, scars and large cysts tend to destroy familiar landmarks.

B. The exact plane of the excision is often difficult to determine at operation.

C. There is a certain variation in the extent of the striate cortex in different persons.

The ideal method of examination is by means of serial sections through the entire visual system, as emphasized particularly by Brouwer. Such detailed studies often reveal unexpected accessory lesions which alter the entire interpretation. Unfortunately, they have rarely been employed. There are many tantalizing reports of cases (such as that of Holmes's soldier shot through the occipital pole, Behr's case of quadrantic macular scotoma reported by Wilbrand and many cases of surgical extirpation) in which serial sections would settle many controversies, but they are not available.

EVOLUTION OF CONCEPTION OF CORTICAL REPRESENTATION OF MACULA

The Localization of the Cortical Visual Center.—No attempt will be made here to trace the history of the conception, now everywhere accepted, that the primary cortical visual center corresponds to the striate cortex (area 17 of Brodmann), that the external sagittal stratum (formerly known as the posterior longitudinal fasciculus) contains the geniculocalcarine radiation and that both in the calcarine cortex and in the optic radiation the fibers corresponding to the upper retinal quadrants lie superior, those from the inferior quadrants inferior. It is now generally recognized that a large portion at least of the cortical representation of the macula lies at the posterior end of the calcarine fissure. Historical accounts of the development of those theories may

be found in the writings of Henschen (1923), Brouwer (1917) and Putnam (1926 *b* and *c*). Henschen, who did so much to establish the location and organization of the "cortical retina" in the 1890's, and ably documented the representation of the retinal quadrants, never took a leading part in the discussion as to the bilateral representation of the macula.

Origin of the Idea of Bilateral Representation of Central Vision.—An excellent review of the subject was given by Brouwer (1917). The following account is merely an amplification of his.

The idea of the bilateral representation of the macula appears to have been first proposed by Bunge in 1884. He pointed out the frequent occurrence of preserved central vision in homonymous hemianopia and attributed it to the double or collateral innervation of the fovea and macula, resulting from an "interweaving or alternation of the fibers of the crossed and the uncrossed bundles . . . which takes place in the optic nerve," which he believed he was able to demonstrate (in a case of syphilitic optic nerve atrophy with concentric contraction). He was, however, at a loss to explain why it sometimes did and sometimes did not appear in hemianopic fields.

Wilbrand adopted Bunge's hypothesis and sought to document it by an imposing series of cases summarized in a brilliant monograph in 1890, which has apparently not been carefully read by many subsequent authors who have built on its conclusions. From a survey of many visual fields, including some taken by Foerster, Wilbrand felt that he could demonstrate:

1. That in many cases of severe injury to the chiasm, optic nerve, tract or cortex producing hemianopia, remnants of vision may be found in the macular area or along the vertical dividing line (48 out of 77 cases). This fact has been amply demonstrated since.

2. That in other apparently similar cases, including those presumably resulting from unilateral lesions of the occipital lobes, a complete hemianopia or even a small hemimacular scotoma might result. This statement has also been supported by many subsequent investigators.

3. That the preserved area of vision in cases of incomplete hemianopia can seldom be correctly called macular, as it often fails to correspond with the anatomic size and shape of the fovea and may extend up and down the vertical dividing line. Many examples of such fields have since been published, but Wilbrand's criticism of them appears to have been forgotten.

4. That the "ueberschuessige Gesichtsfeld," as he called it (the overlapping field, not the macular representation), could not be explained as the result of a decussation of fibers in the corpus callosum, as he had

observed it in a case in which the entire radiation and homolateral geniculate body had been destroyed, judging from macroscopic examination.

Wilbrand laid considerable emphasis on this point in order to combat Foerster's suggestion (1890) that the preservation of central vision in cases of hemianopia was due to the existence of an especially favorable blood supply to the corresponding area of the cortex.

On the basis of a critical review of his material, Wilbrand evolved the hypothesis that there was a normal variation in the extent of bilateral representation of the overlapping fields and that some subjects were certainly without it. He made no attempt to distinguish between lesions of the optic tract and those of the radiation and implied that the bifurcation of fibers took place in the retina or nerve. His later attempts (1913) to find an anatomic basis for a bifurcation of fibers have been criticized by Lenz (1927), Brouwer (1917) and others and need not be considered here.

Wilbrand's conception that the bilateral representation of the overlapping field exists in some subjects and not in others has disappeared almost as completely as the doctrine that the pyramidal tracts may fail to decussate, current at the same time. All subsequent writers and Wilbrand himself (1925-1926) have abandoned the idea. The paucity of satisfactory autopsy reports among his cases make them difficult to evaluate—for example the one in which there was a remnant of vision all along the vertical dividing line after a lesion involving the whole tract and geniculate body. Some of his other cases seem wholly incompatible with the conception of a bilateral representation in all subjects, as he himself pointed out.

The hypothesis was well launched, however, and appeared to receive further support from Heine, who in 1900 also proposed a theory of bilateral representation to account for the phenomenon of stereopsis. Heine presented no clinical or experimental proof, reaching his conclusion on purely empiric grounds (in part anticipated by Wilbrand, 1890). He pointed out that the most likely point for the decussation of macular fibers was not in the chiasm or in the region of the external geniculate bodies but in the splenium of the corpus callosum. He chose this region by a process of elimination.

Heine considered three possible mechanisms:

1. Each cone might be connected with two fibers, one to each hemisphere (essentially as suggested by Bunge). He rejected this because it would preclude the possibility of macular splitting in any case of homonymous hemianopia.

2. There might be a dichotomy of fibers in the chiasm, as suggested by Wilbrand. One would then expect that macular bundle to be twice as large in the optic tract as in the nerve, and this he felt was not true.

3. There must then be a central commissural bundle in the caudal end of the corpus callosum.

Heine's arguments should apply to the peripheral field as well as to the macula. To explain the undoubted cases of complete hemianopia after lesions of the optic radiation, he suggested the fairly frequent occurrence of anomalous failure of bilateral representation. According to Heine's theory, the subjects of such an anomaly should lack stereoscopic vision. Most recent students of stereopsis consider it a complex function not exclusively dependent on correspondence of homologous retinal points. Patients suffering from complete hemianopia retain the power of stereopsis. Section of the corpus callosum produces no apparent disturbance of stereopsis or perception of depth (Akelaitis).

Wilbrand later (1907) cited Foerster's (1890) case of bilateral homonymous hemianopia with preserved central vision as supporting evidence for his theory. In his first monograph, he had pointed out (quite justly, it would seem) that the existence of similar cases should be considered evidence against a bilateral representation of the macula. Foerster's patient later came to autopsy, and the observations were reported by Sachs:

The patient had two successive cerebral vascular accidents, losing first the right and then the left homonymous fields of vision. Although the patient was able to fixate only by looking at the end of his finger, Foerster was able to map out an area of central vision extending to 1 degree on the right and 3 degrees on the left. Visual acuity was reported normal. The patient had some disturbance of orientation in space.

At autopsy, Sachs observed that there was a small island of striate cortex at the right occipital pole and a still smaller one on the left. He considered the latter to be functionless, because the stratum sagittale internum was destroyed. His illustrations show, however, that a small portion of the stratum externum was intact, and subsequent investigations (Putnam 1926*a*) have shown that this fiber system is the geniculocalcarine radiation. Sachs could not accept Foerster's view that preservation of the macular representation was the result of an especially favorable blood supply.

A number of similar cases have since been reported (Sachs). In all except 1 of the cases we have found in which the examination was thorough, traces of calcarine cortex were present on the side corresponding to the area of least remaining central vision, which has usually been dismissed by those observers who adhere to the theory of bilateral representation. The location of the residual cortex is variable; in some instances it has lain at the occipital pole and in others it has approached the anterior end of the striate area. The significance of many of the earlier cases has been obscured by the fact that the internal sagittal stratum was considered to be the optic radiation at the time they were reported.

The one exception is the case of Bencini, in which, however, there was difficulty with perimetry and the autopsy observations were not well described or illustrated.

In this connection, it is perhaps worth while to point out that cases of complete blindness resulting from bilateral lesions of the hemispheres have been reported (see Wilbrand and Saenger, 1917), though they appear to be rarer than cases of bilateral hemianopia with preserved central vision.

Another cornerstone of Wilbrand's conception was the famous case of Eggert, in which autopsy was performed by Henschen (1892). Consideration of the case has been reserved for this point, because its significance was largely overlooked at the time by both Wilbrand and Henschen. Its importance lies in the fact that it is the only case of

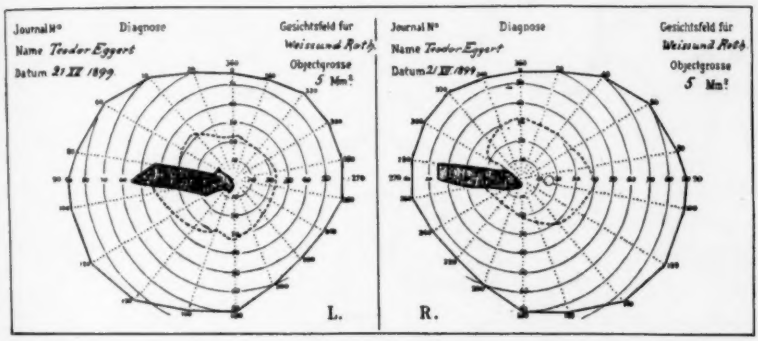


Fig. 2.—Paramacular scotoma in the case of Eggert. (After Henschen, 1909, volume 4.)

unilateral scotoma involving the macula in which a satisfactory autopsy report is available.

In this case, Wilbrand found homonymous left-sided band-shaped scotomas which lay about 10 degrees from the horizontal meridian and extended into the macular fields, sector fashion, reaching the vertical dividing line just below the fixation point (fig. 2). Peripherally they approached the 50 degree line. Pathologic examination showed a softening in the floor of the calcarine fissure from the tip to the parieto-occipital fissure in the right hemisphere (fig. 3). In addition, there were other old lesions in both occipital poles, not affecting the striate cortex or radiation except to a minimal extent on the left side, probably too small to be detected by perimetry.

Wilbrand (1890) at one time and Henschen considered this case as evidence for bilateral representation, the latter taking it for evidence that the tips of the occipital poles do not belong to the visual center.

The experience of almost every other student of this problem is against such an inference (Wehrli, Lenz, Brouwer, Holmes, Putnam) though it is doubtless true that there is great variation in the configuration of the posterior end of the striate area. Wehrli pointed out that even if there was a unilateral lesion producing a horizontal sector scotoma reaching from the fixation point to the periphery, it was actually overwhelming evidence that Wilbrand's theory of bilateral representation

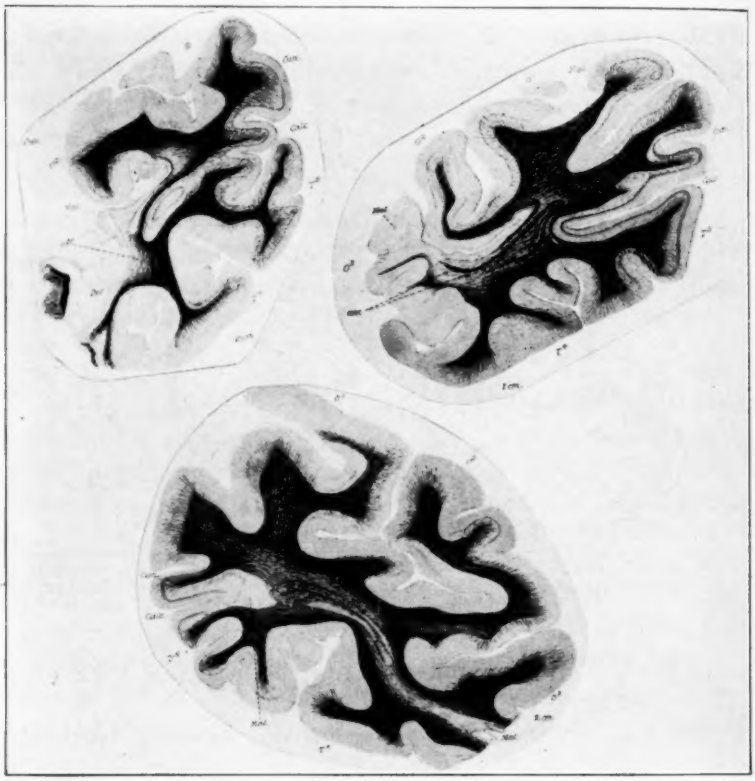


Fig. 3.—The lesion in the floor of the calcarine fissure, extending 2 cm. from the pole, in the case of Eggert. Note that the radiation is also involved. (After Henschen, 1909, volume 4.)

could not be correct, for double representation should prevent the encroachment of the scotoma on the macular field. This objection was later admitted by Wilbrand (1926).

This case unfortunatley gives no information as to whether the macula is represented anteriorly or posteriorly in the calcarine fissure.

Many other cases of unilateral and bilateral central scotoma, mostly following wounds of the occiput, have since been reported (see Wilbrand

and Saenger, 1917). Wilbrand and Saenger, however, reported several instances of bilateral hemianopia with only central vision spared as a result of apparently similar wounds. Only 2 other cases of central scotoma with autopsy appear to have been reported: that of Holmes (1931), in which a macroscopic destruction of the posterior 4 cm. of the occipital poles due to a gunshot wound was found, and that of Behr (cited by Wilbrand and Saenger, 1917), in which there was a small cyst of softening in the tip of one occipital pole. In a case reported by Malbrán and Balado, a unilateral central scotoma was apparently produced by operative trauma to the tip of the occipital lobe. The rarity of central scotomas resulting from vascular lesions is striking.

The "Decentralist" Argument.—About 1900, Wilbrand's theory of bilateral representation of the macula became absorbed into the controversy between the "centralists" (von Munk, Foerster, Henschen, Wilbrand, Lacqueur and others) and the 'decentralists" (led mainly by von Monakow and his pupils) concerning the cortical projection of the retina.

Von Munk first advanced the idea that the macula possesses a relatively small, insular cortical center corresponding closely in size and shape to the macular visual field.

The school of thought which first bitterly opposed this idea was that of von Monakow and Wehrli. They expressed the opinion that there is a relatively diffuse, unlocalized, though rich cortical representation of the macula. Their evidence was partly based on the material cited by Wilbrand which has been mentioned. Von Monakow considered the postulated bilateral cortical macular representation unnecessary to explain "macular" sparing in either unilateral or bilateral homonymous hemianopia. He said that it could be explained equally well by a diffuse representation of the macula in such a manner that the small remnants of a damaged cortex would be sufficient to maintain some central vision.

Wehrli admitted that the macula has a favored position in the cortex but said that this is by virtue of an extremely wide distribution. He pointed out that there was no good anatomic evidence for the existence of a central macular decussation.

A large portion of the "decentralist" argument rested on the erroneous assumption that the stratum sagittale internum was the geniculocalcarine radiation. There can now be no doubt that there is a fairly discrete representation of the retinal quadrants, limited to the striate cortex. It appears, however, that the macula has a large representation, perhaps extending to the anterior end of the calcarine fissure. To this extent von Monakow and Wehrli were correct.

The Representation of the Macula in the Geniculate Body.—The "decentralist" argument rested largely on von Monakow's experimental

anatomic studies on the projection of the macula on the lateral geniculate body. He and his followers insisted that it was a diffuse one, that the macular fibers not only had a large representation in this ganglion but that it was entirely unlocalized. The diffuse representation in the cortex was inferred by analogy.

A large body of evidence has since been accumulated which wholly disproves this thesis. Parsons reported in 1904 a series of experimental lesions produced in the retinas of monkeys. He showed that there was a definite localization of the macula in the middle third of the optic tract. Rönne in 1910 and later in 1914 reported several cases of toxic amblyopia in which the degenerated macular fibers terminated almost exclusively in the middle third of the lateral geniculate body. The definitive work of Brouwer and Zeeman, who produced cleancut degenerations in the geniculate bodies of apes by sharply localized lesions of the fovea, proved beyond reasonable doubt that although the macular representation in the geniculate body is extensive, it is nevertheless well localized in the dorsomedial part of the geniculate body. Brouwer and Zeeman stated that their results pointed to a synthesis of the views of the centralists and the decentralists.

Revival of the Concept of Bilateral Representation.—In 1909 Lenz entered the controversy, and in two important papers (1909 and 1914) he reviewed the evidence on which were based the concepts of the cortical representation of the retina. He was led to conclude that the decentralist view was untenable, that there existed an exact point to point representation of the retinal quadrants on the occipital cortex, that there was a definite localization of the macula at the occipital poles and that Wilbrand's idea of a bilateral representation must be correct.

Against von Monakow's view, Lenz was able to offer little more than theoretic objections in 1909, although subsequent anatomic investigations showed that he was largely correct. He pointed out that small macular hemianopic scotomas prove that, even for the macula, strict projection on the cortex exists in principle. He cited the case observed clinically by Wilbrand wherein such field defects were caused by a 13 mm. screw lodged in the posterior pole of the brain. Many more cases have since been recorded (Holmes).

He was, however, unable to explain why any unilateral occipital lesion such as this should produce a macular scotoma if the representation is bilateral.

Lenz also utilized cases from the Russo-Japanese War reported by Inouye and in his latest review added the data of Holmes and Lister and Marie and Chatelin obtained from cases of gunshot wounds during the World War.

Since it was impossible adequately to examine this material during wartime, reports of autopsies and microscopic studies are lacking and

the value of these cases are questionable. Lenz's doctrine of predominant representation of the macula at the occipital pole has been supported by more recent investigations based on serial sections (Putnam, 1926 *b* and *c*). He and also von Munk, Henschen and others appear to have been mistaken in believing that the macula is represented in a small area in the cortex.

After reviewing the evidence gathered by Wilbrand and Saenger (1917), Henschen (1912) and Foerster (1890), Lenz decided that there must be a bilateral representation but that the decussation could not be in the chiasm, as maintained by Wilbrand. He agreed with Heine, who on purely theoretic grounds had placed the site of the decussation in the splenium of the corpus callosum and said:

> It can be asserted with certainty that typical macular sparing occurs only in lesions of the most central part of the visual pathway. In a lesion of the primary visual centers or the starting points of the visual radiation, the dividing line passes through the fixation point in the greatest number of cases. Lesions of the optic tracts and chiasm behave similarly. . . . The boundary between the above-mentioned occurrence of macular sparing and the lack thereof lies somewhere in the middle third of the parietal lobe, and cases exist which point to this region, cases which at first showed macular sparing, then macular splitting as the lesion progressed forward.

To explain the failure of the appearance of macular sparing in occasional patients with lesions of the occipital cortex, Lenz assumed that isolated decussating fibers might be spared in some lesions and destroyed in others. He presented as evidence his famous case (1909) in which a patient with an occipital tumor first showed macular sparing and later macular splitting. He interpreted this to mean that the bilateral representation of the macula in both cortices was responsible for the preservation of central vision until the tumor, spreading anteriorly, finally destroyed the decussating bundle. This patient came to autopsy, and an extensive occipital tumor was identified, but no microscopic report was given. There is no proof of the point of origin or progress of the tumor.

Cushing and others have shown that tumors of the temporal lobe, even anterior to the corpus geniculatum, may also cause first an incomplete and then a complete hemianopia. It is, therefore, obvious that such cases do not serve to demonstrate bilateral representation of the macula.

Rönne's Theory of Hemiamblyopia.—Lenz maintained that there were many cases of "macular sparing" in which there was no diminution in visual acuity. His data are not wholly convincing, however. Rönne in 1911 produced evidence that the remnant of vision in a hemianopic field following a central lesion seldom possesses normal acuity. (In the cases collected by Wilbrand and Saenger in 1917, diminution of

acuity in the preserved central portion of a hemianopic field, or after a bilateral hemianopia, was the rule, but normal acuity was occasionally found.)

Rönne stated the belief that "macular" sparing is merely a special type of hemiamblyopia as the remnant of a lost visual field. He suggested that when a lesion causes a diminution in function of an entire half of the retina, the peripheral fields fall below the threshold of response to light stimuli. The more densely innervated macular retina, however, having a lower threshold, is still able to preserve some of its sensitivity. He further proposed to account for "macular" sparing on the basis that the macular cortical center is larger than that of peripheral vision. Hence, there is a greater probability that part of the "macular" cortex will remain intact even in the presence of large lesions. He suggested that hemiamblyopias are the most common field defects, just as hemipareses are more common than hemiplegias. Rönne was particularly interested in the fact that so-called "macular" sparing may be so slight that there is great difficulty in deciding whether it is present at all, for one finds all transitions in which fully developed "macular" sparing passes over into macular splitting and back again to sparing as evidence in favor of his theory.

In commenting on the variability of "macular" sparing, Rönne remarked:

> It can be absent at first and later make its appearance; it may be lacking in one eye and be present in the other. It may further be so small that one is in doubt whether it is present or not; it may be so large that one is forced to suppose that it is combined with residuals of the fibers from the periphery. It may be demonstrable by means of colored objects but not by white ones in the presence of hemiamblyopia; but the reverse may be the case. In brief, the boundaries are so large that this very fact is an argument against giving an explanation of the phenomenon which is founded on the assumption of a peculiar anatomic arrangement of distribution of fibers, while it finds its natural explanation from the point of view discussed here.

Rönne gave examples of fields of all the types mentioned.

Contributions from War Injuries.—The work of Inouye has already been mentioned. The World War provided opportunity for many other observations, which have been ably reviewed by Wilbrand and Saenger (1918) and by Best. Particularly outstanding was the series reported by Holmes and Lister, on the basis of which they were able to construct a map of the occipital cortex which is in the main still accepted.

There are two chief objections to deductions from war injuries. The first is that in many instances the perimetry was performed under difficult conditions. The second and more serious objection is that anatomic localization depends on inference from the track of the pro-

jectile or on gross observations at autopsy. In no crucial instances were serial sections examined. Three general conclusions appear justified on the basis of sheer weight of numbers and clinical observations even under difficult circumstances:

1. The upper quadrants of the retina are represented in the upper portion of the occipital lobe (but whether in the upper portion of the radiation, upper portion of the calcarine cortex or both is uncertain from the cases presented).

2. Isolated unilateral central scotomas may occur, obviously strong evidence against a bilateral representation of the macula. This suggestion has already been discussed in connection with Wilbrand's case of Eggert (Henschen, 1892).

3. The major portion of the representation of the macula is at the occipital pole. This statement is strongly suggested by the cases of unilateral macular scotoma, in some of which the scotoma was produced by a superficial wound of the occipital pole. Apparently the only case with autopsy was that reported by Holmes and Lister. A soldier received a bullet wound transversely through one occipital lobe; he lost central vision to about the 20 degree circle; gross inspection of the brain showed the area of destruction to extend from the occipital pole 4 cm. forward.

The possible sources of error in this important case were obvious. Wilbrand (1890) Brouwer (1917) and others have published cases in which hemianopia with sparing of central vision has resulted from apparently similar injuries.

Wilbrand's Later Views.—In 1926 Wilbrand published a most important paper in which he admitted the justification of the criticisms of Lenz and Rönne. Moreover, he seemed to have renounced the idea of bilateral representation. He said: "Now if at one time I believed that macular sparing had to be explained by the principle of *Doppelversorgung,* knowledge has since been so advanced through the experiences of the World War that I should like to take up another point of view based on Rönne's theory."

He admitted the contention of Rönne that the frequent occurrence of atypical "macular" sparing, in which the boundaries of the color fields deviate from those of form or in which there is a definite diminution in visual acuity, is better explained on the supposition that such sparing represents a remnant of a hemiamblyopic field. He also admitted that central sector scotomas of varying shapes extending in toward the fixation point or with a long axis parallel to the horizontal meridian (as in the case of Eggert) are more easily accounted for in the same manner than by the old idea of bilateral representation.

Wilbrand elaborated Rönne's hypothesis to the extent of considering both the macular and the peripheral field to be represented in the cortex by physiologic sensory units. Those for the macula are scattered over a relatively large area and are connected by association fibers. Since these macular physiologic sensory units are relatively far apart but numerous, the encroachment of a lesion on one or more of them would leave many others free to function. The preservation of color vision and of visual acuity would then depend merely on the number of units affected.

Lenz in 1927 remained unshaken in his loyalty to the bilateral representation theory despite Wilbrand's surrender. His chief criticism of the Rönne-Wilbrand proposal lay in the fact that "macular" sparing often remains in its original form for many years, if we correctly interpret his rather involved argument.

This criticism appears unjustified, for any variation in the shape of the spared area or in its visual acuity should be a function only of the underlying pathologic process. If one is dealing with an expanding lesion, one naturally expects progressive destruction of macular cortex and macular fibers in the radiation (as in Lenz's case of tumor discussed previously). If, on the other hand, one is dealing with a softening or traumatic lesion, one may encounter macular splitting with a subsequent return to "macular" sparing (as described by Balado and Malbrán and by Hyndman). The term "hemiamblyopia," especially in the Rönne-Wilbrand sense, carries no specific implication of progression or regression.

Lenz's second objection is that if one considers, with Wilbrand, that the central 1 or 2 degrees represents one physiologic sensory unit, and the central 3 to 5 degrees represents another, then one must renounce the fundamental principle of a point to point projection demanded by the substitution of the spared units for the destroyed ones.

The justification for this objection is also difficult to maintain. The Rönne-Wilbrand theory implies no such substitution of intact elements for destroyed ones but holds that all elements are equally affected and that impulses from the macula reach the cortex because the macular portion of the retina possesses a lower threshold for sensory stimuli.

Moreover, Lenz felt at last able to present anatomic "proof" of his macular callosal commissure. For in 1925 Pfeifer stated that he had found a bundle of fibers which left the visual radiation and passed over to the opposite hemisphere through the corpus callosum in the brain of a baby at term (fig. 4). He seemed certain at that time that these fibers were macular fibers and that they accounted for "macular" sparing according to the view of Heine and Lenz.

His work was repeated (Putnam, 1926*c*) in Brouwer's laboratory with a much more accurate technic (wax reconstruction). The group

of fibers described by Pfeifer was identified and traced under high magnification. It was found that these fibers ended in the homolateral occipital cortex after a complicated "bayonet" course. This fact was corroborated by Krainer. Moreover, careful study was made of the serially sectioned brains of two adults with suitable degenerations, but no evidence was found of the existence of fibers running from one geniculate body to the opposite cortex.

In 1930 Pfeifer was far less definite concerning the existence of a decussating bundle, stating: "My own investigations of myelogenetic preparations show that if such callosal fibers do branch off, the spot where the division takes place can be indicated with great probability."

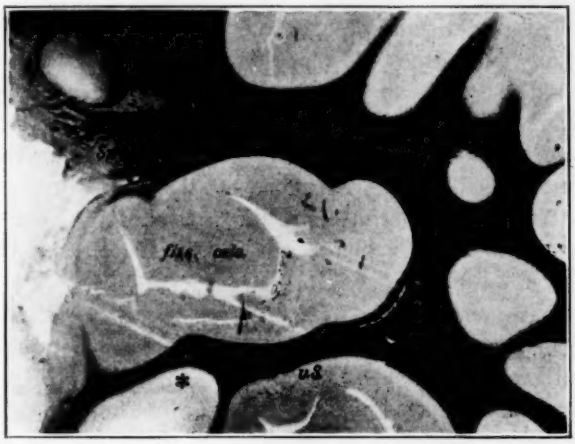


Fig. 4.—Pfeifer's illustration (1925) of the supposed origin of decussating fibers from the optic radiation. "Origin of the fasciculus corpus callosi cruciatus (Balkengabel) from the ventral section of the optic radiation."

It appears, therefore, that an anatomic demonstration of the callosal visual pathway is still entirely lacking. The anatomic aspects of the problem are further reviewed elsewhere (Putnam, 1926 *b*).

Anatomic Investigations of Brouwer and His School.—During the first quarter of this century, most of the investigations of the central representation of various portions of the retina and the anatomy of the central visual system were based on perimetric observations, often rather crude. A new precision was introduced by Brouwer, of Amsterdam, and his co-workers and pupils between 1923 and 1933 by the analysis of the course of degenerations produced by small localized lesions. First, the results of experimental lesions of the retina in various animals, including apes, were studied (Brouwer and Zeeman). By this means it was clearly demonstrated that the macula has an enormous represen-

tation which occupies the body of the corpus geniculatum in primates. This was a complete and definite corroboration of Rönne's observations on human beings (Rönne, 1914 *d*). The upper and lower retinal quadrants, much larger in area but far more sparsely provided with retinal elements, were represented in small "horns" of the geniculate body.

When this much was settled, it became possible to trace the representation of the various portions of the geniculate body—hence of the retina—in the occipital cortex by means of a study of human beings in whom small arteriosclerotic lesions had occurred (Putnam, 1926 *b*). The cases studied, with a few other suitable ones from the literature, demonstrated conclusively that the mesial extremity of the geniculate body, representing the upper quadrant of homonymous retinal halves, is represented in the upper portion of the striate area. The lateral portion of the geniculate body, representing the lower retinal quadrants, is represented in the lower portion of the striate area. Fibers coming from the body of the corpus geniculatum and therefore constituting the macular representation course in the center of the optic radiation and end mainly in the posterior extremity of the striate area. They are, however, extremely numerous, far outnumbering all others, and it is possible that a minority of them reach the anterior portion of the striate area.

The conclusions reached were not entirely new, having been announced in part by Hun, Lenz (1927), Holmes and Lister, Rönne (1919) and others. They were now demonstrated with certainty by purely anatomic methods, however, and have not been questioned since. They have been confirmed in detail in experiments on monkeys by Polyak.

Of equal importance for the problem of the representation of the macula was the study of the anatomy of the optic radiation. The significance of the results in relation to the theory of bilateral representation of the macula has been discussed in connection with the work of Lenz and Pfeifer.

Among other studies, one of the Amsterdam group of papers (Putnam, 1926 *b*) contained the report of a case in which there was an extensive lesion of one occipital lobe, while the occipital cortex, radiation and geniculate body on the other side were intact. A special study was made of the geniculate body on the normal side; no degenerations were found in it.

This observation is, of course, important evidence against a callosal geniculocalcarine tract. It has been confirmed by Krainer and Suwa, by German and Brody and in monkeys by Polyak. A case reported by Juba (1934), on the other hand, was interpreted by the author as

evidence that a lesion of one occipital lobe may cause a secondary degeneration in the opposite geniculate body. The brain in Juba's case contained multiple embolic lesions, however, and the supposedly intact occipital lobe was examined only by means of a few random sections. The case can scarcely be given the same weight as the others reported.

Definite as were the findings of Brouwer and his pupils, they were subject to certain limitations. As regards the present problem, the most serious one was a lack of precise information concerning the anterior extent of the macular representation. Both Putnam (1926 *a*)

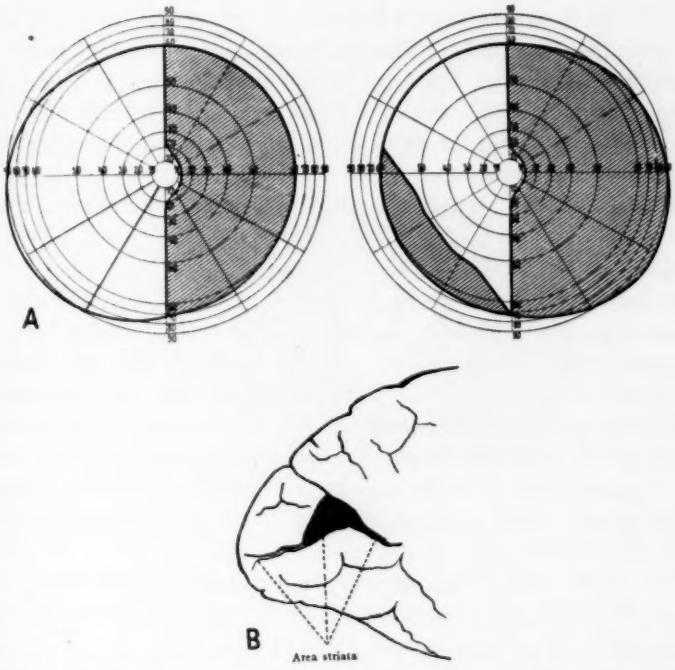


Fig. 5.—*A*, visual fields in Brouwer's case (1930). *B*, location of the lesion in the case.

and Brouwer (1930) had to rely largely on cases in the literature. Of these, the most instructive seemed to be Holmes and Lister's case of gunshot wound of the occipital pole and Wilbrand's (1890) case of Eggert. In 1 of Brouwer's own cases, a lesion of the anterior end of the calcarine fissure resulted in homonymous hemianopia with a sparing of central vision (Brouwer, 1913; fig. 5). In another, central vision appeared (by candle perimetry) to be spared when only remnants of the anterior and middle portions of the striate area remained (Brouwer, 1917).

The Surgical Period.—With the great increase of the scope of neurologic surgery after the World War, a new source of evidence in regard to the anatomy of the visual system became available. Operations on the occipital lobe for tumors and other pathologic structures, extensive extirpations and even stimulation of the primary visual centers were reported.

The first important paper was that of Foerster in 1928. The case on which he laid chief emphasis was as follows: A patient of 35 presenting a syndrome of mania, ataxia, vomiting and choked disk was operated on for a presumed tumor of the quadrigeminal region. The right occipital lobe was exposed and retracted away from the midline and tentorium. The tentorium was incised, and the splenium was split for a distance of 2 cm. The quadrigeminal region was widely exposed. Nothing pathologic was found. As the right occipital lobe was extensively prolapsed, so that the skull could not be closed, the posterior pole was resected for a distance of 5 cm.

Ten weeks after operation, the patient showed a complete hemianopia, the division passing through the fixation point. (No fields were illustrated.)

The author interpreted this case as evidence of destruction of a decussating pathway through the splenium, which produced a complete hemianopia after resection of the occipital lobe. From the description of the operation, during which there must have been forceful retraction over the anterior end of the calcarine cortex as well as complete destruction of its postventricular portion, the conclusion seems scarcely justified.

As if aware of some deficiences in the evidence, Foerster referred to Pfeifer's "proof of the existence of . . . a callosal tract," which has already been considered.

In the same article, Foerster reported a case in which an extensive resection of the occipital lobe was followed by an incomplete hemianopia, with "macular" sparing.

The patient suffered from convulsions with a visual aura. The tip of the occipital lobe and the mesial aspect, including the lower lip of the calcarine fissure, were excised, the line of section passing through the dilated posterior horn. The size of the portion removed was not mentioned but was only indicated on a conventional diagram; the operation might easily have left some of the depths of the fissure behind. Similar cases reported by Balado and Malbrán, by Foerster and Penfield, by Penfield, Evans and MacMillan and by Fox and German will be considered hereafter.

The most significant of the cases reported by Foerster is undoubtedly the one in which he was able to produce crude visual hallucinations by cortical stimulation (faradic). Stimulation of the occipital pole produced photomas directly in front of the patient; stimulation of the upper lip

produced a sensation of light in the lower contralateral visual field; stimulation of the lower lip produced hallucinations in the upper visual field.

Other cases of surgical extirpation in the calcarine region may be summarized briefly. In the case of Balado and Malbrán, a primary operation for cyst of the occipital lobe without removal of tissue produced a macular scotoma. At a later operation, the tip of the occipital lobe was removed—how extensively is not clear. Eighteen days after operation, the fields were normal when tested with a large object, but with a 3/2,000 object, a loss of the peripheral portion of the left field was demonstrated. The paramacular scotoma persisted.

In the case of Foerster and Penfield, a hemianopia with retained central vision followed the excision of the tip of the occipital lobe, which did not pass through the ventricle.

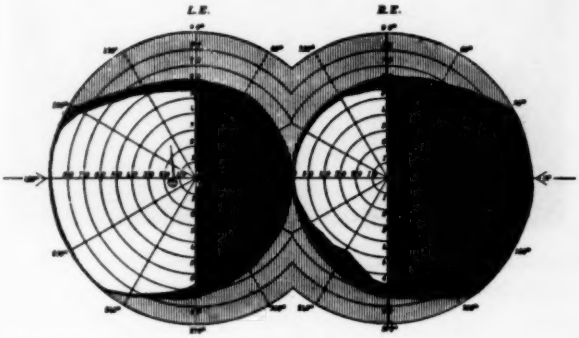


Fig. 6.—Visual fields in a case of Penfield and co-workers one month after operation. Note the small remnant of central vision.

Three cases were reported by Penfield, Evans and MacMillan. In one, an extensive removal of the occipital lobe—the specimen measured 7 by 6 by 3.7 cm. and included the posterior horn of the ventricle—resulted in a hemianopia which spared a tiny remnant of central vision (fig. 6). In the second, less extensive resection resulted in a similar defect. In the third, a lobectomy extending forward to the splenium was followed by a complete hemianopia.

Two similar cases were reported by Fox and German, in which extensive removal of tissue from the occipital lobe resulted in hemianopia with preserved central vision.

The interpretation of such surgical cases is a matter of much difficulty. Penfield, Evans and MacMillan postulated a decussating pathway which they place just at the level of the splenium (fig. 7). A portion of the striate area extends about to this point (fig. 8), however, and it

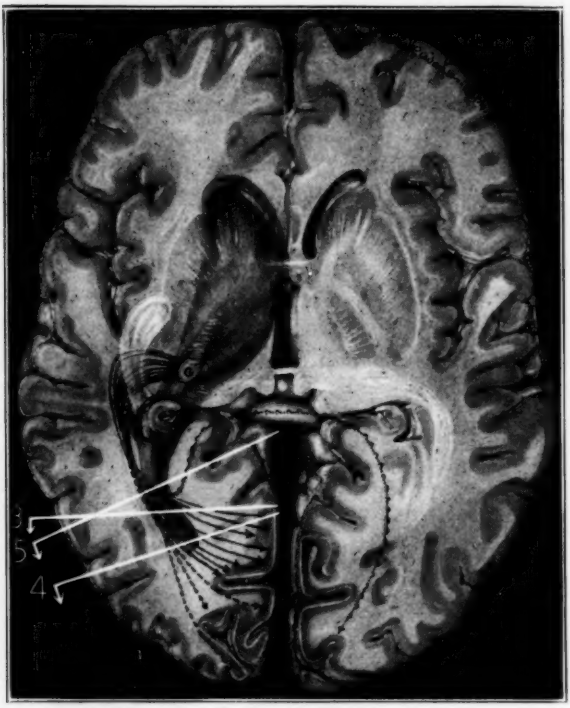


Fig. 7.—Diagram of the extent of operative removal in the cases of Penfield and co-workers. Note the line labeled 4.

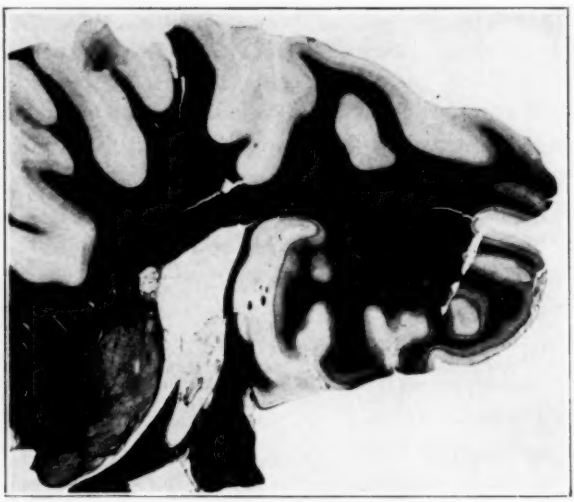


Fig. 8.—Normal occipital lobe for comparison with figure 8. Note the anterior extent of the striate cortex.

is to this fact that Fox and German attributed the remains of central vision in their cases. As no serial sections from any of these cases is available, not one of them can be considered conclusive.

A case reported by Hyndman is a more nearly physiologic experiment than Foerster's. The tip of one occipital lobe was removed in an attempt to remove a tumor; a hemianopia with remnants of central vision resulted. At a later session, the corpus callosum was split for a distance of 2.5 cm.; the fields were unchanged. A similar case was observed by Horrax.

The most accurately studied cases of this type are 2 reported by Halstead, Walker and Bucy. The extirpation of the striate cortex was verified by serial sections of the operative specimen in both. Elaborate precautions against shift in fixation were taken. The objects were exposed with a tachistoscope, too rapidly to permit ocular movements. The absence of ocular movements was further controlled by recording the corneoretinal potentials. Careful observations of visual acuity were made. In one case, the margin of the hemianopic field ran precisely through the fixation point; in the other, there was an irregular remnant of vision, subtending about 2.5 degrees for color and 1.25 degrees for form on the hemianopic side.

A recent and ingenious experiment by Maison, Settlage and Grether is supportive evidence against a bilateral representation of central vision. In monkeys they removed one occipital lobe and cut the contralateral optic tract; the animals appeared to be completely blind. They were not studied by means of the conditioning technic, however.

COMMENT

From the reports summarized, it seems fairly clear that there is much definite anatomic evidence against the existence of fibers from one geniculate body to the contralateral striate cortex (Rönne, 1919 *e*; Putnam, 1926 *e*; Polyak; Krainer and Suwa; Krainer; Maison, Settlage and Grether; German and Brody, and others) and no dependable evidence for it. Pfeifer pointed out the conceivable point of origin of a decussating tract as a suggestion rather than as a serious hypothesis, and reasons have already been given for feeling that Juba's case, in which contralateral degeneration of the geniculate body followed a lesion of one occipital lobe, is more liable to misinterpretation than the cases of Rönne (1919 *e*), Putnam (1926 *e*), Krainer and Suwa and German and Brody.

To turn to the clinical evidence, it appears that all the cases reported of destruction of the tip of the occipital lobe (except the one studied by Halstead, Walker and Bucy) with preservation of central vision can be explained on the assumption that survival of a small portion of the anterior extremity of the calcarine fissure is enough to provide for

a certain amount—perhaps very little—of foveal vision. The striate cortex extends forward to precisely the region of the hypothetic callosal bundle of Lenz, Pfeifer, Foerster and Penfield and others (fig. 8). The cases in which injury to the occipital pole resulted in a unilateral macular scotoma (Wilbrand, 1890; Holmes, 1918 and others) are scarcely compatible with the assumption of a bilateral representation of the whole macula.

At this point, we are confronted by a dilemma. How does it happen that in many cases (of which Wilbrand's case of Eggert [Wilbrand, 1890] is the only one studied by means of serial sections) a small lesion of the tip of the occipital lobe produces a scotoma extending to the fixation point, while in others destruction of the anterior half of the calcarine cortex has the same effect? Enough cases of each type are on record to dispel any reasonable doubt as to their existence. The mere assumption that the macula has an extensive representation is not a sufficient explanation of well established facts. This difficulty was clearly pointed out by Krainer.

We are unable to suggest any explanation of the apparent contradiction, except that perhaps the small central scotomas reported were relative and not complete. There can be no doubt that a large area at the posterior end of the calcarine fissure is devoted to foveal vision. The connections have been clearly demonstrated anatomically. Extensive lesions of this region (perhaps especially those which destroy the radiation as well, as bullet wounds might do) are evidently capable of producing scotomas, and such scotomas, even if not absolute, are obvious to the patient and easily outlined by perimetry. Under these circumstances, it would be difficult for the patient—and even more for the examiner—to be sure that *no* test object would be seen in the scotoma. The existence of even relative unilateral macular scotomas would still constitute substantial evidence against the assumption of bilateral representation.

The situation is exactly reversed if the occipital pole is extensively damaged. Surrounded by a blind field and adjacent to the intact contralateral half of the fovea, an area of even the dimmest central vision may easily be demonstrated. Krainer has pointed out that under these circumstances, the area of retained central vision is always small (usually less than 2 degrees), while it is of variable size and of definite, often irregular shape if the occipital pole is spared (or depths of the posterior half of the calcarine fissure), as in the case of Balado and Malbrán. Test type may be read chiefly by means of the normal half of the macula.

Still another explanation might be based on the work of Adler and Fliegelman, who have shown that a variable shift of fixation is normal. It might be expected that the least remnant of central vision would

attract the attention of the normal half of the macula in a hemianopic patient. According to Fuchs, there is a psychologic shift of the fixation point to the normal side in some hemianopic patients, and certainly many visual fields suggest that this is the case (see Bender and Kanzer).

This hypothesis is somewhat weakened by the observations of Halstead, Walker and Bucy, who took great pains to control fixation. Their first subject had normal vision to 1.25 degrees.

The situation is made no easier to explain by the fact that in Halstead, Walker and Bucy's second case, an apparently similar lesion produced a complete macular splitting.

If central vision is represented in the anterior portion of the striate area, the area presumably devoted to it must lie in the depths of the calvarine fissure (Putnam, 1926 *c*; Holmes, 1931; Horrax and Putnam).

Still another possibility remains to be considered, namely that lower centers may take over the function of gnostic vision to some extent after cortical lesions. That this occurs in rabbits has long been known. Conclusive evidence of the ability of monkeys to distinguish and localize even low intensities of light after bilateral occipital lobectomy has been furnished by Klüver and by Marquis and Hilgard. Thus, Klüver reported of his first monkey subjected to bilateral lobectomy (1937):

> Even the tachistoscopic tests did not yield any significant differences between the pre-and post-operative periods. There was also no difference in situations in which threshold determinations were made (reduction in size of stimuli differing in color or form until no discrimination was possible). A study of the records obtained during several months after the operation, however, indicated the following two changes which were possibly the effect of the operation: (a) the performances were frequently not entirely errorless (5-10 per cent errors); (b) the animal was more disturbed by the introduction of marked variations in the stimulus situation than in the pre-operative tests.

It is usually stated that no such vicarious function of lower centers occurs in man. Actually, there is little evidence for such a statement. There are, to be sure, a small group of cases of "cortical blindness" listed by Wilbrand and Saenger (1917), but they are greatly outnumbered by cases of bilateral hemianopia with retained remnants of central vision. Satisfactory reports of autopsies are lacking. It is possible that some cases of "cortical blindness" were instances of visual agnosia due to involvement of secondary visual centers. Further, it would not be surprising if the degree of "diaschisis" of function of lower centers following injury to the cortex should vary somewhat from case to case. On the whole, it seems to us that this is the most satisfactory explanation of such findings as those of Halstead, Walker and Bucy and some of those of Penfield. It is obvious that this explanation does not invalidate the other facts—large area of representation of the macula, favorable blood supply of the occipital pole—which doubtless account for the findings in some cases.

The complete hemianopia which is often reported in cases of a lesion of the temporal lobe may be due to involvement of the geniculate body, either directly or through its blood supply, by the lesion.

A scheme of the organization of the central visual system is presented in figure 9.

Objectives of Further Investigation.—The representation of the fovea and of the retinal quadrants in the geniculate body and optic radiation appears to be definitely demonstrated. So do the representation of the retinal quadrants in the striate cortex and the fact that the posterior portion of the cortex is predominantly concerned with central vision. A sufficient number of cases of unilateral injury to the tips of the occipital lobe, with retention of more or less or no central vision, are on record to make the reporting of more seem superfluous

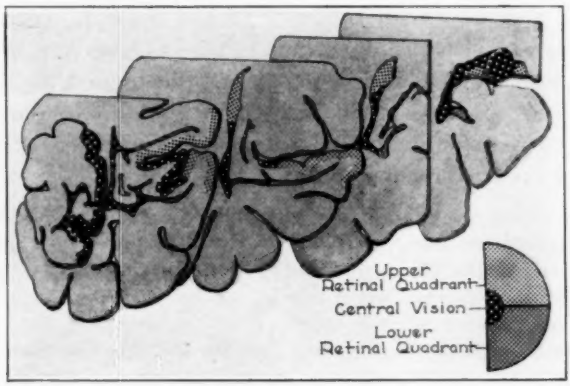


Fig. 9.—Diagram of the location of fibers from the upper and lower quadrants of the retina in the geniculate body, optic radiation and striate cortex. There is doubtless some overlapping of central vision with adjacent territories.

unless they are studied with the exacting care of the cases of Halstead, Walker and Bucy. Serial sections of the optic radiation in such a case might settle the problem.

There is, however, a real lack of cases of bilateral hemianopia and cortical blindness with satisfactory study by means of serial sections. The number of cases of severe unilateral injury to the striate cortex with careful study of the contralateral geniculate body (and cortex) is still small enough to permit some doubt as to the uniformity of the results. An anatomic study of cases of a unilateral macular scotoma resulting from a cortical lesion is urgently needed; indeed, even a clinical study by means of the stereocampimeter and quantitative perimetry would be of value. More accurate data on the normal shift of fixation and the deviation to the normal side in cases of hemianopia might be

obtained. With such information, the picture of the framework of the anatomic mechanism of the central visual system would be substantially complete.

SUMMARY

1. A review of the literature on the cortical representation of the macula, with especial reference to the problem of "macular sparing," has been presented.

2. The preponderance of evidence is in favor of an extremely large representation of central vision at the posterior end and in the depths of the calcarine fissure. It is possible that central vision has some representation even at the anterior end of the fissure and if so doubtless in the portion adjacent to the ventricle.

3. There is no satisfactory anatomic evidence of a callosal bundle uniting one geniculate body with the striate cortex of the opposite side, and there is considerable evidence that such a decussating pathway does not exist. The clinical cases on the basis of which such a decussating pathway has been postulated are better explained by other hypotheses.

4. Many cases are on record in which a homonymous hemimacular scotoma has existed, but in only 1 of these has the brain been examined in serial sections. The lesion was found at the tip of the occipital lobe. In all cases, the lesion has been traumatic and has presumably injured the optic radiation.

5. Lesions of the anterior portion of the striate area on one side produce a contralateral hemianopia with a large remnant of central vision. Lesions of the tip of the occipital pole produce a hemianopia with irregular boundaries, sometimes with only 1 or 2 degrees of central vision. Neither type of central field is actually "macular."

6. Total or subtotal lesions of one occipital lobe may produce either a complete hemianopia or one with varying traces of central vision.

7. The persistence of central vision in cases of a lesion of the occipital lobe may be due to any one of several factors. One is the extensive representation of macular vision, probably occupying over half the area of the visual cortex and possessing a blood supply from three sources.

8. Another explanation of the tiny remnants of central vision following extensive lesions is that there is a constant physiologic shift of fixation, so that an object in the hemianopic field but near the fixation point may be brought into view. In some cases, there is evidence of the formation of a new fixation point within the preserved field.

9. Finally, it seems likely that a certain degree of visual perception may be taken over by lower visual centers after occipital lesions, as clearly occurs in monkeys.

710 West One Hundred and Sixty-Eighth Street.

BIBLIOGRAPHY

Adler, F. H., and Fliegelman, M.: Influence of Fixation on the Visual Acuity, Arch. Ophth. **12**:475-483 (Oct.) 1934.

Akelaitis, A. J.: Studies on the Corpus Callosum: II. The Higher Visual Functions in Each Homonymous Field Following Complete Section of the Corpus Callosum, Arch. Neurol. & Psychiat. **45**:788-796 (May) 1941.

Allen, I. M.: Clinical Study of Tumours Involving the Occipital Lobe, Brain **53**:194-243, 1930.

Balado, M.; Adrogué, E., and Franke, E.: Alteraciones de la función visual en los casos de lesión del lóbulo occipital izquierdo, Arch. argent. de neurol. **15**:19-53, 1936.

——and Malbrán, J.: Sobre la localización cortical de la mácula en el hombre, Acción méd. **2**:107-124, 1931.

Beevor, C. E.: On the Course of the Fibres of the Cingulum and the Posterior Parts of the Corpus Callosum and Fornix in the Marmoset Monkey, Phil. Tr. Roy. Soc., London, s.B **182**:135-199, 1892.

Bencini, A.: Reperto anatomo-patologico in un caso di doppia emianopsia con conservazione del campo visivo maculare; contributo allo studio delle vie visive cerebrali, Riv. di neurol. **1**:353-376, 1928.

Bender, M. B., and Kanzer, M. G.: Dynamics of Homonymous Hemianopias and Preservation of Central Vision, Brain **62**:404-421, 1939.

Best, F.: Ergebnisse der Kriegesjahre für die Kenntnis der Sehbahnen und Sehzentren, Zentralbl. f. d. ges. Ophth. **3**:193-207, 1920.

Brouwer, B.: Ueber die Sehstrahlung des Menschen, Monatschr. f. Psychiat. u. Neurol. **41**:129-158 and 203-234, 1917.

Ueber die Projektion der Makula auf die Area striata des Menschen, J. f. Psychol. u. Neurol. **40**:147-159, 1930.

Projection of the Retina on the Cerebral Cortex in Man, A. Research Nerv. & Ment. Dis., Proc. **13**:529-534, 1932.

——and Zeeman, W. P. C.: Experimental Anatomical Investigations Concerning the Projection of the Retina on the Primary Optic Centers in Apes, J. Neurol. & Psychopath. **6**:1-10, 1925.

The Projection of the Retina in the Primary Optic Neuron in Monkeys, Brain **49**:1-35, 1926.

Bunge, P.: Ueber Gesichtsfeld und Faserverlauf im optischen Leitungsapparat, Habilitationsschrift, Halle, M. Niemeyer, 1884.

Cushing, H.: Distortions of the Visual Fields in Cases of Brain Tumour: VI. The Field Defects Produced by Temporal Lobe Lesions, Brain **44**:341-396, 1922.

Dimmer, F.: Die Makula lutea der menschlichen Netzhaut und die durch sie bedingten entoptischen Erscheinungen, Arch. f. Ophth. **65**:486-544, 1907.

Foerster, O.: Ueber Rindenblindheit, Arch. f. Ophth. **36**:94-108, 1890.

Beiträge zur Pathophysiologie der Sehbahn und der Sehsphäre, J. f. Psychol. u. Neurol. **39**:463-485, 1929.

——and Penfield, W.: Der Narbenzug am und im Gehirn bei traumatischer Epilepsie in seiner Bedeutung für das Zustandenkommen der Anfälle und für die therapeutische Bekämpfung derselben, Ztschr. f. d. ges. Neurol. u. Psychiat. **125**:475-572, 1930.

Fox, J. C., Jr., and German, W. J.: Macular Vision Following Cerebral Resection, Arch. Neurol. & Psychiat. **35**:808-826 (April) 1936.

Fuchs, W.: Untersuchungen über das Sehen der Hemianoptiker und Hemiamblyoptiker, Ztschr. f. Psychol. u. Physiol. d. Sinnesorg. Abt. 1 **84**:67-169, 1920.

German, W. J., and Brody, B. S.: External Geniculate Bodies: Degeneration Studies Following Occipital Lobectomy, Arch. Neurol. & Psychiat. **43**: 997-1006 (May) 1940.

Halstead, W. C.; Walker, A. E., and Bucy, P. C.: Sparing and Nonsparing of "Macular" Vision Associated with Occipital Lobectomy in Man, Arch. Ophth. **24**:948-966 (Nov.) 1940.

Heine, L.: Sehschärfe und Tiefenwahrnehmung, Arch. f. Ophth. **51**:146-173, 1900.

Henschen, S. E.: Klinische und anatomische Beiträge zur Pathologie des Gehirns, Upsala, Almqvist & Wiksell, 1890-1909, vols. 1-4.

Spezielle Symptomatologie und Diagnostik der intrakraniellen Sehbahnaffektionen, in Lewandowsky, M.: Handbuch der Neurologie, Berlin, Julius Springer, 1912, vol. 3, pp. 751-810.

Vierzigjähriger Kampf um das Sehenzentrum und seine Bedeutung für die Hirnforschung, Ztschr. f. d. ges. Neurol. u. Psychiat. **87**:505-535, 1923.

Holmes, G.: Disturbances of Vision by Cerebral Lesions, Brit. J. Ophth. **2**:353-384, 1918.

A Contribution to the Cortical Representation of Vision, Brain **54**:470-479, 1931.

——and Lister, W. I.: Disturbances of Vision from Central Lesions, with Special Reference to the Cortical Representation of the Macula, ibid. **39**:34-73, 1916.

Horrax, G.: Personal communication to the authors.

——and Putnam, T. J.: Distortions of the Visual Fields in Cases of Brain Tumor: VII. The Field Defects and Hallucinations Produced by Tumors of the Occipital Lobe, Brain **55**:499-523, 1932.

Hun, H.: A Clinical Study of Cerebral Localization, Illustrated by Seven Cases, Am. J. M. Sc. **93**:140-168, 1887.

Hyndman, O. R.: The Central Visual System: Evidence Against Bilateral Representation Through Splenium of the Corpus Callosum, Arch. Neurol. & Psychiat. **42**:735-742 (Oct.) 1939.

Inouye, T.: Die Sehstörungen bei Schussverletzungen der kortikalen Sehsphäre, Leipzig, Wilhelm Engelmann, 1909.

Juba, A.: Ueber das Projektionsfeld des zentralen Sehens im äusseren Kniehöcker und in der Sehrinde des Menschen, Ztschr. f. d. ges. Neurol. u. Psychiat. **147**: 121-144, 1933.

Die kortikale Doppelvertretung der Makula und die Projektion der Sehrinde auf den äusseren Kniehöcker des Menschen, Klin. Monatsbl. f. Augenh. **93**: 595-608, 1934.

Klüver, H.: An Analysis of the Effects of Removal of the Occipital Lobes in Monkeys, J. Psychol. **2**:49-61, 1936.

Certain Effects of Lesions of the Occipital Lobes in Macaques, ibid. **4**:383-401, 1937.

Visual Functions After Removal of the Occipital Lobes, ibid. **11**:23-45, 1941.

Krainer, L.: Zur Anatomie und Pathologie der Sehbahn und der Sehrinde, Deutsche Ztschr. f. Nervenh. **141**:177-190, 1936.

——and Suwa, K.: Zur anatomischen Projektion und zur Lehre von der Doppelversorgung der Macula, Jahrb. f. Psychiat. u. Neurol. **53**:35-44, 1936.

Lagrange, B. I., and Garcin, R.: Sur un cas de cécité corticale par ramollissement des deux cunéi: Étude anatomo-clinique, Rev. neurol. **1**:417-427, 1929.

Lenz, G.: Zur Pathologie der cerebralen Sehbahn unter besonderer Berücksichtigung ihrer Ergebnisse für die Anatomie und Physiologie, Arch. f. Ophth. **72**:1-85 and 197-273, 1909.

Die hirnlokalisatorische Bedeutung der Makulaaussparung im hemianopischen Gesichtsfelde, Klin. Monatsbl. f. Augenh. **53**:30-63, 1914.

Ergebnisse der Sehsphärenforschung, Zentralbl. f. d. ges. Ophth. **17**:1-26, 1927.

Maison, G. L.; Settlage, P., and Grether, W. F.: Experimental Study of Macular Representation in the Monkey, Arch. Neurol. & Psychiat. **40**:981-984 (Nov.) 1938.

Marie, P., and Chatelin, C.: Les troubles visuels dus aux lésions des voies optiques intracérébrales et de la sphère visuelle corticale dans les blessures du crâne par coup de feu, Rev. neurol. **22**:882-925, 1914-1915.

Scotomes paramaculaires hémianopsiques par lésion occipitale et scotome maculaire par lésion rétinienne unilatérale chez le même blessé, ibid. **23** (pt. 2):112-115, 1916.

Les troubles visuels consécutifs aux blessures des voies optiques centrales de la sphère visuelle corticale; hémianopsies en quadrant supérieur; hémiachromatopsies, ibid. **29** (pt. 1):138-140, 1916.

Marquis, D. G., and Hilgard, E. R.: Conditioned Responses to Light in Monkeys After Removal of the Occipital Lobes, Brain **60**:1-12, 1937.

Meyer, A.: The Connections of the Occipital Lobes and the Present Status of the Cerebral Visual Affections, Tr. A. Am. Physicians **22**:7-16, 1907.

Minkowski, M.: Sur les conditions anatomiques de la vision binoculaire dans les voies optiques cérébrales, Encéphale **17**:65-96, 1922.

von Monakow, C.: Experimentelle und pathologisch-anatomische Untersuchungen über die optischen Centren und Bahnen nebst klinischen Beiträgen zur corticalen Hemianopsie und Alexie, Arch. f. Psychiat. **23**:609-671, 1892; **24**: 229-268, 1892.

von Munk, H.: Zur Anatomie und Physiologie der Sehsphäre der Grosshirnrinde, Sitzungsb. d. k. preuss. Akad. d. Wissensch. **2**:996-1013, 1910.

Parsons, J. H.: The Arris and Gale Lectures on the Neurology of Vision: Lecture I. The Afferent Visual Paths, Lancet **1**:1029-1034, 1904.

Lecture II. The Innervation of the Pupil, ibid. **1**:1102-1105, 1904.

Penfield, W.; Evans, J. A., and MacMillan, J. A.: Visual Pathways in Man with Particular Reference to Macular Representation, Arch. Neurol. & Psychiat. **33**:816-834 (April) 1935.

Pfeifer, R. A.: Myelogenetisch-anatomische Untersuchungen über den zentralen Abschnitt der Sehleitung, Monographien aus dem Gesamtgebiete der Neurologie und Psychiatrie, Berlin, Julius Springer, 1925, vol. 43.

Hirnpathologischer Befund in einem Fall von doppelseitiger Hemianopsie mit Maculaaussparung, J. f. Psychol. u. Neurol. **40**:319-337, 1930.

Polyak, S. L.: The Retina, Chicago, University of Chicago Press, 1941.

Putnam, T. J.: (*a*) Studies on the Central Visual System: II. A Comparative Study of the Form of the Geniculo-Striate Visual System of Mammals, Arch. Neurol. & Psychiat. **17**:285-300 (Sept.) 1926.

(*b*) Studies on the Central Visual Connections: III. The General Relationship Between the External Geniculate Body, Optic Radiation nad Visual Cortex in Man; Report of Two Cases, ibid. **16**:566-596 (Nov.) 1926.

(*c*) Studies on the Central Visual System: IV. The Details of the Organization of the Geniculo-Striate System in Man, ibid. **16**:683-707 (Dec.) 1926.

Putnam, T. J., and Putnam, I. K.: Studies on the Central Visual System: I. Anatomical Projection of the Retinal Quadrants on the Striate Cortex of the Rabbit, ibid. **16**:1-20 (July) 1926.

Ramón y Cajal, S.: Histologie du système nerveux de l'homme et des vertebrés: Généralités, moelle, ganglions rachidiens, bulbe et protuberance, ed. française traduite de l'espagnol par Dr. L. Azoulay, Paris, A. Maloine, 1904.

Rönne, H.: (*a*) Pathologisch-anatomische Untersuchungen über alkoholische Intoxikationsamblyopie, Arch. f. Ophth. **77**:1-95, 1910.

(*b*) Ueber die Bedeutung der makulären Aussparung im hemianopischen Gesichtsfelde, Klin. Monatsbl. f. Augenh. **49**:289-312, 1911.

(*c*) Ueber doppelseitige Hemianopsie mit erhaltener Makula, ibid. **18**:470-487, 1914.

(*d*) Die anatomische Projektion der Makula im Corpus geniculatum ext., Ztschr. f. d. ges. Neurol. u. Psychiat. **22**:469-485, 1914.

(*e*) Ueber Quadranthemianopsie und die Lage der Makula-fasern in der okzipitalen Sehbahn, Klin. Monatsbl. f. Augenh. **63**:358-374, 1919.

Sachs, H.: Das Gehirn des Förster'schen Rindenblinden, Arb. a. d. psych. Klin. in Breslau **2**:53-104, 1895.

Traquair, H. M.: Fields of Vision in Intracranial Lesions, Brit. M. J. **2**:229-231, 1933.

Van Valkenburg, C. T.: Experimental and Pathologico-Anatomical Researches on the Corpus Callosum, Brain **36**:119-165, 1913.

Walker, C. B.: Quantitative Perimetry: Practical Devices and Errors, Arch. Ophth. **46**:537-561, 1917.

Wehrli, E.: Ueber die anatomisch-histologische Grundlage der sog. Rindenblindheit und über die Lokalisation der corticalen Sehsphäre, der Macula lutea und die Projektion der Retina auf die Rinde des Occipitallappens, Arch. f. Ophth. **62**: 286-375, 1906.

Wilbrand, H.: Die hemianopischen Gesichtsfeld-Formen und das optische Wahrnehmungscentrum, Wiesbaden, J. F. Bergmann, 1890.

Ueber die makulär-hemianopische Lesestörung und die v. Monakowsche Projektion der Makula auf die Sehsphäre, Klin. Monatsbl. f. Augenh. **45**:1-39, 1907.

Die Theorie des Sehens: Zwei Vorträge gehalten während der akademischen Ferienkurze zu Hamburg, Wiesbaden, J. F. Bergmann, 1913.

Ueber die makuläre Aussparung, Ztschr. f. Augenh. **58**:261-268, 1925-1926.

——and Saenger, A.: Die Neurologie des Auges, Wiesbaden, J. F. Bergmann, 1906, vol. 3, pt. 2, pp. 475-1097.

Die Neurologie des Auges, ibid., 1917, vol. 7.

Die Verletzungen der Sehbahnen des Gehirns mit besonderer Berücksichtigung der Kriegsverletzungen, ibid., 1918.

Zwanenburg, S.: Quantitatief onderzoek over den bouw van het netvlies, Amsterdam, J. van Boekhoven, 1915.

UNUSUAL DISCIFORM RETINAL LESION WITH HETEROTOPIA MACULAE

BENJAMIN FRIEDMAN, M.D.
NEW YORK

The interesting features of the case under consideration lie in the unique appearance of a unilateral fundus lesion and in the malplacement of the macula relative to a normally positioned nerve head.

REPORT OF A CASE

The subject, H. W., aged 27, an otherwise healthy man, stated that the vision in the right eye had always been poor. He had been informed by his mother that obstetric instruments were employed in the course of his birth and that the attending physician had requested consultation with an ophthalmologist because he had noted "something wrong" with the right eye of the infant. The findings of the oculist were obscured in doubt, but the patient was convinced that trauma to the eye had occasioned the specialist's visit. It is extremely unlikely that a village practitioner would have noted the retinal lesion, and it does not seem probable that he would have insisted on obtaining the opinion of an oculist had not external evidences of injury been apparent. That the external trauma must have been transitory is evident from the present natural appearance of the lids, orbit and anterior part of the bulbus.

Right Eye.—The vision was 20/400 with the following correction: + 3.00 D. sph. ⊃ + 2.00 D. cyl., axis 30.

On using the ophthalmoscope, one's attention was at once attracted to a button-like lesion which lay in the region of the macula. The lesion was perfectly circular and was of a uniform canary yellow color. Its area was slightly more than half that of the nerve head, the edges being sharp and clear. Adjacent to this yellow disk was a narrow coronula of fine retinal pigment. Some pigment had been deposited on the yellow button in the form of a small black stripe near the upper nasal periphery. The yellow disk was covered to a large extent by a thick bluish white membrane; this film obscured the yellow color except at the margins, but a hole in one part of the veil revealed the underlying color distinctly. At one spot the membrane extended a short distance beyond the margins of the button in a downward and nasal direction as a pointed prolongation. Inspection with the binocular ophthalmoscope revealed that the yellow button occupied the entire thickness of the retina; the membrane covered the retinal lesion intimately. The triangular extension, however, was definitely anterior to the retina, and the tip appeared to wave slightly in the vitreous with the ocular motion. A number of glistening traction lines surrounded the figure except in the vicinity of the pointed part of the membrane. The traction lines seemed to originate from the borders of the white membrane and appeared to override the marginal surface of the yellow disk.

Further consideration disclosed the nerve head to be normal in appearance, but the superior and inferior temporal arteries and veins swung down and out instead

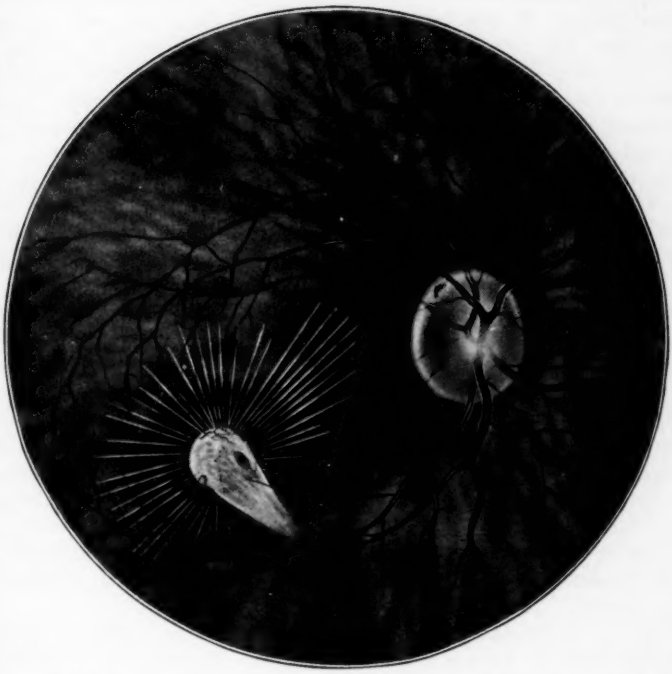


Fig. 1.—Ophthalmoscopic appearance of disciform retinal lesion with heterotopia maculae.

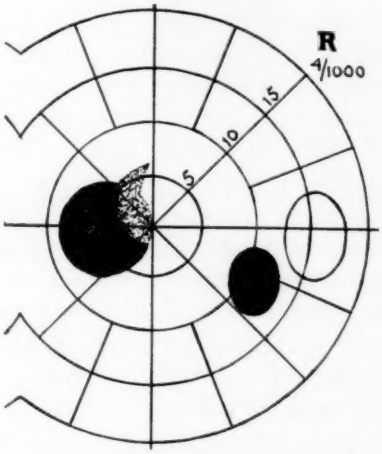


Fig. 2.—Study of the central field to indicate the relative size and position of the scotomas due to the retinal lesion and the optic nerve head.

of extending horizontally, and the terminations of these vessels lay all around the retinal lesion. It now became apparent that the yellow disk occupied the macular region but that the whole macular area was displaced downward and nasally. The upper border of the yellow button was about ½ disk diameter below the lower margin of the nerve head. Approximately 1¼ disk diameters separated the nearest points of the lesion and the nerve. The retinal lesion possessed both an arterial and a venous circulation.

When the patient's eye was in the primary position, the observer, looking straight in, saw a normal retina; furthermore, and this is an important point, the nerve head appeared to lie in its proper position relative to the direct line of observation. The retinal lesion and the confluence of the macular terminals were noted in a position downward and nasal to the normal position of the macula.

Perimetry: With the tangent screen at 1 meter and fixation on a 7 mm. white target, it was possible to outline faithfully the scotoma produced by the retinal lesion, even to the extent of delineating a hornlike extension due to the pointed part of the white membrane. The scotoma covered an area 6 degrees in diameter and was displaced nasally from the fixation point. The nasal third and the extension of the scotoma were relative in intensity, and fixation appeared to take place in the nasal edge of this relatively blind area. The major portion of the scotoma was absolute in character. The lesion cast a longer scotoma than might be expected from its appearance. The blindspot was of normal size, but it was displaced inward from its normal position about 4 degrees, and its upper edge was 7 degrees below the horizontal fixation level instead of being well above it. The peripheral field was normal.

Muscles: A slight right hypotropia was evident, but no change of position was detected by means of the cover test or with the Maddox rod. There was no cyclophoria or cyclotropia.

Left Eye.—Vision was 20/15 with the following correction: + 3.00 D. sph. + 2.00 ⌒ D. cyl., axis 150. Except for the refractive error, this eye was normal in all respects.

COMMENT

Cases of heterotopia maculae are rare. Triebenstein[1] (1919) reported 2 cases and cited only 4 others. In most of these cases the condition was bilateral and the maculas were displaced outward, so that the eyes were in a divergent position on fixation. There was an associated heterotopia of the optic nerves. Looking directly into the eye, the observer saw the nerve head instead of the macula. A frequent finding was the presence of connective tissue strands which extended from the disk to the retina or into the vitreous. Pigmentary degeneration of the retina simulating retinitis pigmentosa was noted by Triebenstein in his patients. No lesions of the type I have described were present in any of the recorded cases. Beselin[2] has reported a case of upward displacement of both maculas.

I cannot say with certainty whether in my patient the lesion originated before or after birth, but the weight of evidence indicates a causal

1. Triebenstein, O.: Klin. Monatsbl. f. Augenh. **62**:442, 1919.
2. Beselin: Klin. Monatsbl. f. Augenh. **73**:691, 1924; **74**:780, 1925.

relationship to trauma during parturition. The yellow-gold color was reminiscent of the appearance of blood which has been imprisoned between the corneal lamellas, and it might be reasonable to consider the lesion as an unusual sequela of a retinal hemorrhage. An organized membrane over the macula would conceivably exert traction on that part of the retina, and it is noteworthy that the displacement of the macula corresponded with the direction of the membranous extension. The traction lines radiated in a backward and lateral direction from this line.

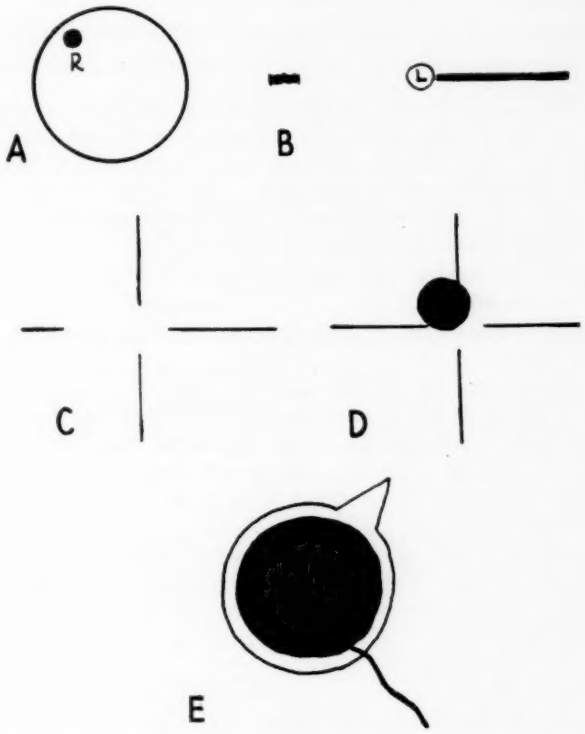


Fig. 3.—*A*, position of the corneal reflex (*R*) of the right eye during fixation. *B*, relative position of the horizontal line caused by the Maddox rod in front of the right eye and the fixation light (*L*) seen by the left eye. *C*, the Bielschowsky cross after-image. The horizontal limbs are seen by the right eye and the vertical by the left. *D*, the Bielschowsky cross is seen as an after-image by the left eye. Simultaneously, the lesion is visualized entoptically by the right eye; its position relative to the macula is depicted by the black circle. *E*, scotoma cast by the lesion by Weekers' method.

Incidentally, how can one explain on the basis of traction the cases in which the membrane was anchored to the disk and the macula was displaced temporally instead of nasally?

The macula at birth is closer to the disk than it is later in life, and it seems plausible that in my patient the retinal lesion prevented the lateral shift of the macula, at the same time drawing it downward.

I have based the diagnosis of heterotopia maculae on the following premises: The fixation point in the retina was adjacent to the lesion; the lesion lay outside the normal position of the macula; the fixation point in the retina and the macula were identical (normal retinal correspondence). Hence it follows that the macula was displaced from its normal position.

The following observations and experiments are offered to substantiate these premises and to prove the validity of the conclusion.

1. When the patient fixated with the right eye he brought it down and in, thus moving the lesion and the adjacent fixating portion of the retina up and out. In this position the corneal reflex was seen near the limbus at about 11 o'clock, thereby creating a large negative angle alpha and a smaller positive vertical angle alpha (fig. 3 *A*). On being instructed to look into the ophthalmoscope light, the patient brought the retinal lesion squarely into view.

2. Studies of the central field indicated the proximity of the lesion to the fixating spot of the retina.

3. The vessel terminals which are ordained for macular nutrition were grouped all about the lesion.

4. When the Maddox rod was held before the right eye so as to form a luminous horizontal line, the center and most of the nasal part of the line were caught in the scotoma (fig. 3 *B*). When the left eye was opened to fixate the light source, the image of the left eye lay at the same level as the horizontal line, and it lay just within the temporal portion of the defect noted in the horizontal line.

5. The Bielschowsky after-image test revealed a congruity of the right and the left macular position (fig. 3 *C*). The centers of the vertical and the horizontal arms of the cross were in the same projected locus, indicating normal macular correspondence. The arm seen by the right eye exhibited a defect close to the macular position.

6. When the complete Bielschowsky cross was seen as an after-image by the left eye and the position of the lesion was envisioned entoptically by the right eye, after the manner of Drews,[3] a juxtaposition of the lesion and of the fixating part of the retina was evident (fig. 3 *D*). Fixation, judged by this method, was accomplished by the portion of the retina which was just adjacent to the upper nasal edge of the lesion.

7. Another interesting, if not altogether pertinent, finding was a positive scotoma which could be readily elicited by Weekers' method (fig. 3 *E*). This took the form of a dark circle surrounded by a narrow lighter zone. The latter was connected with a hornlike projection. A short dark line extended down and temporally from the scotoma, beginning at the 5 o'clock position. This line seemed to coincide with the location of a macular artery which coursed upward and nasally relative to the lesion.

6 West Seventy-Seventh Street.

3. Drews, L.: Am. J. Ophth. **24**:1403, 1941.

THE CORNEA

IV. HYDRATION PROPERTIES OF THE WHOLE CORNEA

V. EVERETT KINSEY, PH.D.
AND
DAVID G. COGAN, M.D.
BOSTON

In the preceding paper of the present series [1] studies on the swelling of corneal pieces were reported. It was noted that swelling considerably above normal levels occurred in solutions of all the nine electrolytes, including sodium chloride, and in solutions of all four of the nonelectrolytes tested (concentration varying from 0 to 2 times molar). Swelling also occurred in a wide range of hydrogen ion concentrations (p_H 1.0 to 14.0).

The object of the present study on corneal swelling is to elucidate the properties of the various structural components of the cornea, especially in relation to the maintenance of a normal level of corneal hydration. This study is intimately bound up with the question of why the cornea does not swell in situ when bathed by solutions which in vitro cause corneal material to quadruple in weight. The probable answer to this question, as well as additional information about the nature of the corneal layers, has been obtained by investigating the swelling of the whole cornea under a number of conditions.

Few earlier workers were concerned with why the normal cornea is not swollen in situ, and no one had performed any considerable quantitative investigation intended to clarify this problem.

All the earlier work appears to have been influenced by the conclusions of Leber,[2] who found that removal of the endothelium resulted in a threefold increase in corneal thickness. He concluded from this fact that the endothelium is impermeable to water and normally prevents corneal turgescence simply by preventing water from reaching the stroma. No explanation was offered as to why water entering the cornea from the limbus does not produce swelling.

---

1. Kinsey, V. E., and Cogan, D. G.: The Cornea: III. Hydration Properties of Excised Corneal Pieces, Arch. Ophth. **28**:272 (Aug.) 1942.

2. Leber, T.: Studien über den Flüssigkeitswechsel im Auge, Arch. f. Ophth. (pt. 2) **19**:87-186, 1873.

Ulrich [3] has been practically alone in believing that the endothelium is permeable to water. In support of this contention he cited the experiments in which he placed ox and pig corneas with scleral rings in a "damp chamber" for one and one-half to three hours and noted that when an excised intact cornea contained aqueous in its concavity the amount of swelling was greater than when it did not contain aqueous. Still greater degrees of turgescence were noted when he removed the endothelium. Leber explained Ulrich's [4] results on the basis of damaged endothelium.

Bullot [5] found that when whole enucleated eyes with the epithelium removed were bathed in 0.02 to 0.16 molar sodium chloride solution they became hypertensive but the corneas did not swell; whereas when they were bathed in solutions above 0.12 molar (sic) concentration they became hypotensive and the corneas swelled considerably. Bullot apparently believed that the increased intraocular pressure prevented the absorption of fluid through the front surface of the corneas and explained the swelling which occurred in the hypertonic solutions on the basis of a lowered intraocular pressure. Because corneal pieces had been shown previously to turgesce less in the higher concentrations of sodium chloride, the swelling was not attributed to the direct action of the solution on the corneas.

An apparent exception to the observation that hypotonic solutions did not produce swelling was distilled water. Bullot, who stated that the endothelium, like the epithelium, is impermeable to water, explained the observed swelling in distilled water on the basis of damage done to the endothelium by an oxygen-deficient solution which presumably allowed the entrance of aqueous into the cornea.

Fischer [6] irrigated the corneal surface with various solutions for one hour and reported that the resultant opacity, which he took to be an index of swelling, increased according to the Hofmeister series. The significance of this finding is limited by the absence of quantitative data and by the fact that no attention was paid to the p_H or to the relative amount of opacity with the same salts at other time intervals. Fischer did not explain what prevented the cornea from swelling normally.

Since all previous theories to explain the fact that the normal cornea is not swollen in vivo are based on the assumption that both surface

3. Ulrich, R.: Zur Ernährung der Hornhaut, Arch. f. Augenh. **36**:46-57, 1898.

4. Ulrich, R.: Einiges zur Flüssigkeitsbewegung im Auge, Ber. ü. Versamml. d. ophth. Gesellsch. **25**:279, 1896.

5. Bullot, G.: On Swelling of Organic Tissues: Researches on the Cornea, Am. J. Physiol. **12**:297-303, 1904.

6. Fischer, F. P.: Untersuchungen über Quellungsvorgänge und über Permeabilitätsverhältnisse der Hornhaut, Arch. f. Augenh. **98**:41-65, 1928.

membranes are impermeable to water and since we have found this to be erroneous,[7] no tenable theory appears to exist at present which will explain this phenomenon.

MATERIALS AND METHODS

Adult cat corneas obtained within several hours after the death of the animals were used for all the experiments. In these studies, unlike those involving corneal pieces, only one hydration measurement could be made on each cornea. Since a determination of the original state of hydration would necessitate the destruction of the cornea, it is obvious that some indirect method of estimating the initial state had to be employed. For this purpose a central section 7 mm. in diameter was cut with a cork borer, and its weight was then determined by means of a micro torsion balance. Fourteen untreated corneal sections were found to vary in weight from 45 to 57 mg., with an average of approximately 50 mg. From time to time sections from additional normal corneas were weighed, and with few exceptions the weight was found to lie within this range. After some experience corneas which would yield centrally cut sections appreciably different in weight from 50 mg. could be picked out and discarded.

The method for calculating the amount of swelling was to cut a similar section from the experimental cornea and express its weight as percentage of the average normal weight; e. g., if after an experiment the weight of the corneal section was 100 mg. the swelling would be given as 200 per cent. In addition to the limitations of this method, which were expressed previously,[1] a variation in the starting weight of about 45 to almost 60 mg. would introduce a variation in the example mentioned ranging from 167 to 222 per cent. Despite this source of variation, if multiple determinations are used for each point and significance is assigned only to trends which involve multiple points, the over-all variations do not appear to affect the validity of the conclusion.

The effect of the time after the death of the animal on the weight of the cornea was tested and found, throughout the maximum period involved in any of this work, to influence but little the weight of the sections.

All the corneas used in this study except those labeled "intact" were removed with scleral lips. Corneas in which no membranes were purposely removed were labeled "whole." In other corneas the epithelium or the endothelium and Descemet's membrane (the latter two layers are hereafter referred to only as endothelium) or both were

7. Cogan, D. G., and Kinsey, V. E.: The Cornea: I. Transfer of Water and Sodium Chloride by Osmosis and Diffusion Through the Excised Cornea, Arch. Ophth. **27**:466 (March) 1942.

removed by scraping. The corneas with scleral lips were then either immersed in about 25 cc. of fluid or tied onto graduated tubes to which was added 2 cc. of liquid, and the tubes and the corneas were immersed in 10 cc. of the same or a second liquid, in a manner more fully described before.[7] Because of the extreme fragility of the endothelium all the corneas so removed had an indeterminate amount of damage done to this membrane. The limitation on the conclusions imposed by this damage will be mentioned later. The corneas labeled "intact" were taken from the eyes with the utmost care to insure an undamaged endothelium. In this group the scleral lips were much wider; the iris and the ciliary body were left undisturbed throughout the test period.

In those experiments in which the various layers were removed from the whole enucleated eye the epithelium was scraped off in the manner previously described, but the endothelium had to be removed by gentle stroking with a dull needle point inserted through the optic nerve, lens, etc. This method required practice before results which were considered satisfactory could be obtained, and even then it probably did not give complete removal of the endothelium.

The intraocular pressure was varied in the experiments with enucleated eyes by inserting a hypodermic needle through the optic nerve into the anterior chamber and tying it securely to the nerve sheath. A reservoir of physiologic solution of sodium chloride which could be lowered or raised was connected to the needle by means of a rubber tube.

RESULTS

Figure 1 shows a side view and an equatorially cut view of a normal cat cornea before (*A*) and after (*B*) immersion of the whole cornea in distilled water for 1,200 minutes. It is interesting to observe that the swelling occurs mostly on the back, or endothelial, side of the cornea. The transparency of the swollen cornea is seen to be considerably impaired; a detailed account of the influence of swelling on transparency will appear in a following paper.

The amount of swelling when excised corneas were bathed in sodium chloride solutions of various concentrations for about 1,200 minutes is shown in figure 2. (As a basis for comparison the results previously obtained [1] with corneal pieces are shown as a broken line.) Here it will be seen that the most swelling occurred in distilled water and that the presence of the constituent corneal membranes had little effect on the amount of swelling, except in the case of the "intact" corneas, in which somewhat less swelling was noted. This difference is probably not significant and may be accounted for by the fact that in the "intact" corneas some aqueous always remained; this no doubt changed the distilled water into dilute salt solution. In every instance the degree

of turgescence was considerably less than that found for corneal pieces. This may have been due to the prevention of swelling by the constricting effect of the unswollen sclera. As the concentration of sodium chloride is increased from 0 up to about 1 per cent the corneal swelling decreases under all the experimental conditions; above this concentration the swelling remains at a nearly constant level. The level of absolute swelling throughout this concentration range appears to depend on the integrity

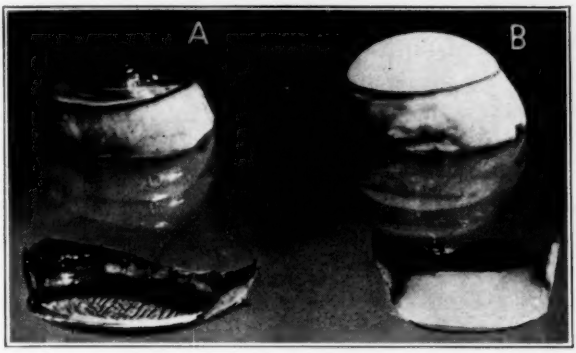


Fig. 1.—Side view (upper) and cross section (lower) of cat corneas with scleral lips. A, normal; B, after immersion of the whole cornea for 1,200 minutes in distilled water.

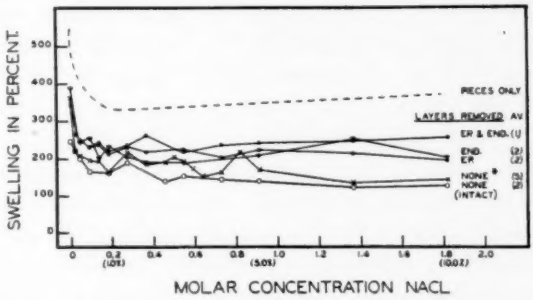


Fig. 2.—The swelling of excised corneas following immersion, with and without removal of the surface membranes, in various strength sodium chloride solutions for 1,200 minutes. The continuous lines indicate the results for whole excised corneas; the broken line, the swelling of corneal pieces.[1] The numerals in parentheses represent the number of corneas tested for each point. The asterisk indicates that the corneas were intact except for an indeterminate amount of damage done to the endothelium coincident with handling.

of the surface membranes, for the amount of corneal swelling without either the epithelium or the endothelium is about 250 per cent, as compared with about 125 per cent for the "intact" cornea. These results

demonstrate that the presence of the surface membranes alters considerably the degree of swelling at least for 1,200 minutes. Since it has been shown [7] that water flows continuously through the surface membranes under similar experimental conditions, the lesser swelling at the higher salt concentrations in the presence of these membranes must be due to the fact that the quantity of water leaving the cornea is almost as great as that entering the cornea. Such a water equilibrium could be explained on the assumption that both the epithelium and the endothelium are semipermeable to sodium chloride and that within the time of the experiment insufficient fluid diffused through the limbus to equalize the salt concentration on the inside and the outside of the cornea.

In the first papers of this series [8] it was shown that the epithelium is actually semipermeable to sodium chloride. The fact that some swelling is observed with solutions which are presumably hypertonic to the cornea (fig. 2) would indicate either that the endothelium has allowed the passage of some sodium chloride or that sodium chloride has leaked into the cornea laterally through the conjunctiva and the sclera.[9]

Experiments designed to clarify the question of endothelial permeability were next performed; they consisted in determining the amount of corneal swelling in selected concentrations of sodium chloride for various times under conditions analagous to those already described. The results of this rate study are summarized in figure 3. Part *B* is a continuation of part *A*, and together they illustrate the rate of swelling for "intact" corneas in a series of solutions of increasing concentration of sodium chloride. As the concentration of sodium chloride increases from 0 to 5 per cent there is a corresponding change in the shape of the first portion of the curves. In distilled water and in weak sodium chloride solutions an initial increase in swelling with time may be observed, whereas with stronger concentrations of sodium chloride an initial deturgescence with time is observed. This initial effect is the result which would be expected if, as previously assumed, the endothelium as well as the epithelium is essentially impermeable to sodium chloride. It is interesting to observe that the 0.75 to 1.25 per cent sodium chloride curves show initially neither a significant increase nor a significant decrease in swelling, thus indicating the approximate concentration of sodium chloride which is isotonic with the cornea. In all instances, by the end of the 1,200 minute test period the swelling had increased to about the level shown for a like period in the previous

8. Cogan, D. G., and Kinsey, V. E.: The Cornea: II. Transfer of Water and Sodium Chloride by Hydrostatic Pressure Through the Excised Cornea, Arch. Ophth. **27**:696 (April) 1942; footnote 7.

9. These membranes, in contrast to the epithelium, have been found to be approximately as permeable to sodium chloride as the corneal stroma.

figure. As previously mentioned, it is not possible from these results to state the reason for this swelling. We are inclined to attribute it to possible leakage through the conjunctiva and the sclera or to damage to the endothelium which occurs in the course of time.

Parts *C* and *D* (fig. 3) show again that removal of either the endothelium or the epithelium results in rapid and appreciable swelling under conditions similar to those outlined. Part *E*, which represents the results of the experiments done on "whole" corneas, shows an intermediate stage of turgescence between parts *A* and *B*, on the one hand, and parts *C* and *D*, on the other, and supports the idea that some damage occurred to the endothelium in the manipulation of the cornea.

Corneal swelling following the immersion of whole enucleated eyes in various strength sodium chloride solutions was next investigated, with the object of testing the compatibility of the results obtained on

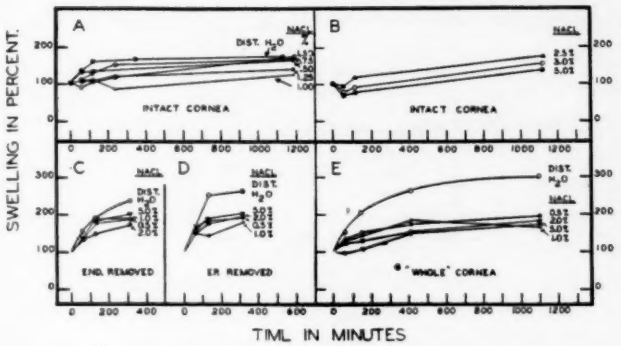


Fig. 3.—The rate of swelling for excised corneas following immersion, with and without removal of the surface membranes, in solutions of sodium chloride of selected concentrations. The asterisk indicates that the corneas were intact except for an indeterminate amount of endothelial damage coincident with handling.

whole eyes with the apparent fact, as determined on excised corneas, that the corneal stroma is covered by two membranes both of which are impermeable to sodium chloride but permeable to water. The lower curve (filled circles) of figure 4 illustrates the amount of corneal swelling found after a 1,200 minute immersion of enucleated eyes when all of the corneal layers were presumably intact. It will be seen that the corneas swelled to only approximately 120 per cent throughout the whole range of concentrations of sodium chloride. This amount corresponds roughly to the amount of swelling previously observed (fig. 2) for excised intact corneas in concentrations of sodium chloride above about 0.5 per cent; below this concentration, however, the isolated corneas appeared to swell considerably more. This difference is readily explained

when it is noted that in experiments with the whole eyes the inner surface is not bathed with the same solutions on both sides but is bathed on the inner side with a solution (aqueous) that is hypertonic to the bath fluid. Thus an osmotic pressure difference is maintained in the presence of a semipermeable membrane (endothelium), and water is withdrawn from the cornea. This is especially striking in the case of distilled water, which produces a swelling of 250 per cent in excised corneas as compared with 120 per cent in corneas in whole eyes.

The curve composed of squares (fig. 4) represents the findings obtained in similar experiments in which the epithelium and the endothelium were both removed before the whole eye was immersed. The resultant swelling for all concentrations was about 250 per cent and appears to be identical with that obtained for isolated corneas under otherwise analogous conditions.

Of greatest interest are the curves showing the swelling after removal of the epithelium or the endothelium alone, i. e. open circles and triangles,

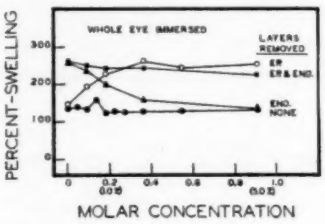


Fig. 4.—Corneal swelling following immersion of enucleated eyes for 1,200 minutes in sodium chloride solutions of various concentrations. Each point on the filled circle curve represents an average of the swelling of 3 corneas, while every other point is an average for 2 corneas.

respectively. It will be noted that with the epithelium removed the swelling increases with the concentration of the test solution, while with the endothelium removed the swelling decreases with the concentration. The general shape of the curve representing epithelium removed is the opposite of that for excised corneas under the same conditions; i. e., swelling increases with concentration instead of decreasing. The magnitude of swelling is also different. In the case of removal of endothelium the shapes of the curves for excised corneas and that of the curve for whole eyes are essentially the same but the magnitude of the swelling is different.

In explanation of these differences it does not appear necessary to make any assumptions regarding the properties of the corneal membranes in addition to those already mentioned, viz. that the endothelium as well as the epithelium is impermeable to sodium chloride. Consider first the

swelling of the epithelial-less cornea when the whole eye was immersed in distilled water: If the endothelium is impermeable to sodium chloride there would be a maintained osmotic pressure resulting in the movement of water from the corneal stroma into the anterior chamber, the accumulation of additional water in the stroma thereby being prevented. As the concentration of sodium chloride in the bathing solution approached that in the anterior chamber, less and less water would be transferred and the cornea would, of course, swell. In still higher concentrations the osmotic pressure would be in the reverse direction, and if the endothelium behaves similarly to the epithelium, an endothelial bulla would be expected to form, thereby destroying the endothelium,[10] with resultant swelling of the cornea. (The mechanism of this bulla formation is described in detail for the epithelium.[7]) The final amount of swelling was indistinguishable from that found when both the epithelium and the endothelium were purposely removed.

The same mechanism would be expected to occur for corneas with the endothelium removed, but since the bath fluid is now on the opposite side of the cornea the effect of concentration on swelling would be in the opposite direction. The results support this idea. Epithelial edema and corneal vesiculation, which are the minimal manifestations of bulla formation, occurred when the eyes were bathed in the distilled water, and it was in this instance that the most corneal turgescence was found. As the concentration of sodium chloride was increased the osmotic pressure prevented water from accumulating in the cornea, and less swelling was observed.

Figure 5 is the counterpart of figure 4 and shows the rate at which corneal swelling occurred when enucleated eyes were immersed in several selected concentrations of sodium chloride. From the lower portion of the chart it will be seen that some swelling occurred almost immediately in distilled water (triangles); by contrast, deturgescence occurred initially in the 5 per cent sodium chloride solution (filled circles). As mentioned with reference to figure 4, after approximately 1,100 minutes the swelling

10. Direct observational evidence that such bullae actually form under similar osmotic conditions was obtained by pressing glass tubes tightly against the epithelial-less corneas of enucleated eyes and introducing 2 cc. of 5 per cent sodium chloride solution in the tubes. The pressure within the eyes was maintained by introducing a hypodermic needle through the optic nerve and connecting this to a reservoir of physiologic sodium chloride solution held about 20 cm. above the eyes. Under these conditions the fluid level in the tube rose slightly at first, and after twenty minutes the endothelium was observed with the slit lamp to have peeled off as a torn membrane. Similar experiments, with distilled water in the tubes instead of 5 per cent sodium chloride, resulted in a decrease in the fluid level, and no damage to the endothelium could be observed with the slit lamp.

was about the same in all the solutions. Leaks of sodium chloride through the conjunctiva and the sclera or the slow permeation of sodium chloride through slightly damaged epithelium or endothelium may have permitted this relatively small amount of swelling.

The upper set of curves shows the swelling under the same conditions except that the epithelium was removed prior to immersion. From these curves it is seen that initially the cornea swelled in 5 per cent sodium chloride solution and shrank in distilled water—just the reverse of what occurred when the epithelium was intact. These results are consistent with the explanation offered to account for the findings reported in figure 4 and support the idea that the degree of corneal turgescence is determined primarily by the presence of intact surface membranes.

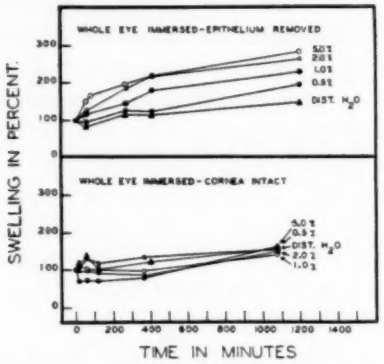


Fig. 5.—Rate of corneal swelling following immersion of enucleated eyes, with and without the epithelium, in solutions of sodium chloride of selected concentrations. Each point is an average of the swelling of 2 corneas.

It was pointed out that in the experiments on isolated corneas the two sides of the corneas were bathed with the same solution, but in the experiments with enucleated eyes one side was always in contact with the aqueous. In every instance in which water was presumed either to leave or to enter the anterior chamber an indefinite amount of osmotic pressure would be operative in determining the amount of swelling. Moreover, the possibility of leakage in both sets of experiments through the conjunctiva and the sclera was always present. For these reasons it was thought desirable to attempt to make somewhat more direct determinations of the effect of osmotic pressure on corneal turgescence. This was done by tying corneas on the ends of glass tubes according to a technic previously described and exposing two sides of them to different concentrations of sodium chloride.

Figure 6 shows the amount of corneal swelling which resulted after 1,200 minutes when corneas, epithelium side up, were tied onto tubes, distilled water was placed in the flasks and sodium chloride solutions of gradually increasing concentrations were placed in the tubes. The different curves represent the swelling which was observed with the indicated membranes removed. It should be recalled that some endothelial damage was present, even though the endothelium was not purposely removed. Because dilution as a result of the movement of water into the salt solution was relatively small, the initial difference in concentration is shown in this chart. (For a plot of the final difference in concentration for the "whole" corneas, see the filled circle curve of figure 7.)

It will be seen from the triangle and square curves, which represent the condition in which the epithelium was removed—in the one case

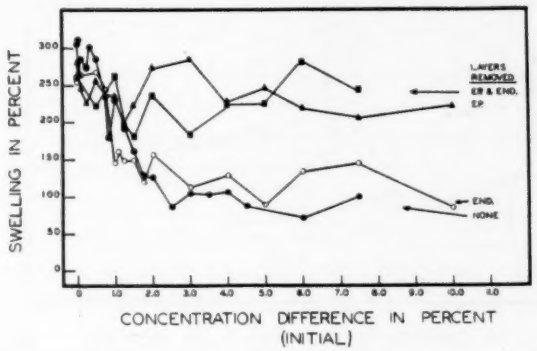


Fig. 6.—Corneal swelling with solutions of different salt concentration on the two sides. The epithelial side of the corneas was in contact with various concentrations of sodium chloride, and the endothelial surface was in contact with distilled water. The corneas were attached to glass tubes. The corneal layers were removed as indicated. The duration of the experiment was 1,200 minutes. Each point represents 3 determinations recorded as initial percentage difference in concentration.

by itself and in the other case along with the endothelium—that swelling amounting to about 250 per cent occurred regardless of the initial difference in concentration of sodium chloride. This is the same result as that found under the same conditions in both the isolated cornea and the enucleated eye experiments (figs. 2 and 4).

In the presence of the epithelium, however, the swelling was about 250 per cent with concentrations of less than 0.5 per cent sodium chloride, but with increasing differences in the concentration of sodium chloride the values decreased rapidly, reaching almost normal hydration values at approximately 2 per cent of sodium chloride. This initial

degree of swelling was felt to be due to the fact that the epithelium became damaged where it was in contact with solutions which were hypotonic to the cornea, and hence the corneal swelling corresponded to that observed where the epithelium had been purposely removed. The osmotic pressure difference was not effective in preventing turgescence unless the tonicity on at least one side of the cornea was above that of the cornea itself.

To prevent the occurrence of epithelial damage in the presence of hypotonic solutions, the experiments with whole corneas were repeated, but a 1 per cent and a 5 per cent solution of sodium chloride were substituted for distilled water in the flasks. The solutions in the tubes were correspondingly increased, so that the differences in concentration on the two sides of the corneas were initially the same as before.

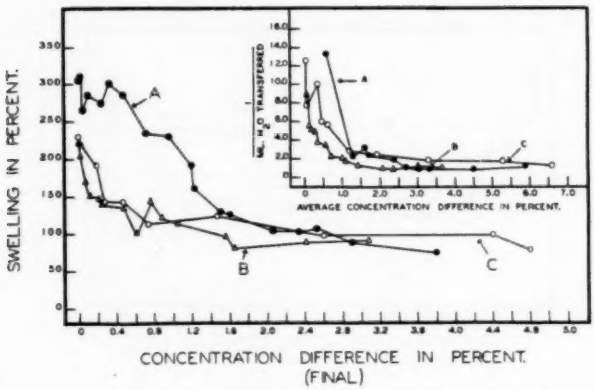


Fig. 7.—Corneal swelling with solutions of different salt concentration on the two sides. The epithelial side of the corneas was in contact with solutions of sodium chloride of various concentrations, and the endothelial surface was in contact with (*A*) distilled water, (*B*) 1 per cent sodium chloride solution and (*C*) 5 per cent sodium chloride solution. The final concentration of sodium chloride on the epithelial side in each instance was higher than that on the endothelial side by the amount recorded as the concentration difference. The corneas were attached to glass tubes. Whole corneas only were used. The duration of the experiment was 1,200 minutes. Each point represents 3 determinations. Inset: the reciprocal of the amount of water transferred with solutions of different salt concentration on the two sides of the corneas. The experiments were identical with those represented in the main part of this figure, and the letters *A*, *B* and *C* have the same significance.

Obviously if water moves from the flask into the tube the solution in the flask will become more concentrated and that in the tube will become more dilute, the initial difference in concentration thus becoming decreased. It was thought that the final difference in concentration

might more exactly account for the degree of swelling, and it is the final difference in concentration which is shown in figure 7 plotted against the swelling. From this figure it will be noted that the amount of swelling was again dependent on the difference in concentration of the sodium chloride solutions on the two sides of the cornea and, in addition, that it decreased more rapidly for the same final difference in concentration in the 1 per cent and in the 5 per cent sodium chloride solution than in the distilled water. Apparently in these solutions, at least for the 1,200 minute test period, a final concentration difference of approximately 1 per cent was necessary to prevent increased hydration, in contrast to almost 2 per cent for distilled water.

Added proof that it is the osmotic pressure between the two sides of the cornea and not some other property of the solutions which accounts for the degree of swelling may be seen from the inset in figure 7. Here the reciprocal of the amount of water transferred in the 1,200 minute period is plotted against the average difference in concentration. This average difference in concentration of the fluids between the tubes and the flasks was obtained mathematically by the solution of parametric equations relating both the amount of water transferred and the difference in concentration to time. It will be seen by comparing the shapes and relative positions of the curves in the inset with those of the figure itself that they correspond well. This means that the amount of swelling is inversely proportional to the amount of water transferred. It is seen from the inset, for example, that when between 0.5 and 1 cc. (the reciprocal shown equals 2 and 1 respectively) of water is transferred, the average difference in concentration is about 1.5 per cent and that above this concentration little additional water is transferred under the conditions of the experiment. Similarly, it may be seen from the main part of figure 7 that with a concentration above about 1.5 per cent the swelling decreases but little.

From the foregoing experiments it seems clear that the amount of corneal swelling is dependent on the concentration of sodium chloride which is maintained on either or on both sides of undamaged surface membranes. Because it was technically impossible to tie a cornea on the end of a tube without some damage to the endothelium, the differences in concentration on the two sides of the excised corneas were probably considerably higher than would be necessary to maintain normal hydration values in the normal eye. Suggestive of this probability were the experiments in which it was found that normal hydration values were maintained for several hours when corneas with undamaged endothelium were bathed in 0.75 to 1.25 per cent sodium chloride solu-

tions. Moreover, it was found possible in these experiments to deturgesce the cornea from its normal water content by increasing the salt concentration above this level.

In all the experiments involving whole eyes the intraocular pressure was, of course, reduced considerably below normal except in those instances in which water entered the eye from a hypotonic solution. Even in these instances the intraocular pressure did not appear to be raised appreciably for more than a few hours. An indication of the contribution of the normal intraocular pressure toward keeping the hydration value of the cornea near normal may be had from the accom-

Swelling of Corneas Following Immersion for 95 Minutes of Whole Enucleated Eyes in Selected Concentrations of Sodium Chloride With and Without Removal of the Epithelium and With Different Intraocular Pressures

Intact Eye *			
Pressure of mercury	0 mm.	20 mm.	185 mm.
Bathing solution	Percentage swelling	Percentage swelling	Percentage swelling
Distilled water	125	111	101
Sodium chloride, 0.5%	120	109	92
Sodium chloride, 1.0%	100	107	97
Sodium chloride, 5.0%	75	56	60
Epithelium removed *			
Pressure of mercury	0 mm.	20 mm.	185 mm.
Bathing solution	Percentage swelling	Percentage swelling	Percentage swelling
Sodium chloride, 0.5%	94	104	97
Sodium chloride, 1.0%	129	128	96
Sodium chloride, 5.0%	177	169	118

* These results are partially taken from figure 5.

panying table, in which the amount of corneal swelling under several intraocular pressures is shown. It was impossible to maintain accurately a pressure of 20 mm. of mercury because of needle blockage; so these results must be considered suggestive only. The 0 and the 185 mm. pressure were, however, satisfactorily maintained. The values for at least 2 and usually 3 corneas were averaged for each entry in the table.

Swelling of the cornea occurs when the intact eye is immersed in a hypotonic solution and in a hypertonic solution when the epithelium is removed before immersion. The reason for this phenomenon is discussed elsewhere in this paper (see fig. 5). It will be seen from the table that when the cornea is swollen pressure exerted intraocularly tends to decrease the amount of swelling. However, it appears that an intraocular pressure in excess of any that occurs in vivo would be necessary to prevent even small increases in swelling.

SUMMARY AND CONCLUSIONS

In an attempt to show why the cornea is not ordinarily swollen, since it is normally bathed with solutions which have been found to produce appreciable swelling of corneal pieces, the following experiments were carried out:

1. Determination of the swelling of excised corneas in various strength sodium chloride solutions with and without the constituent surface membranes.

2. Determination of the swelling of corneas following immersion of whole enucleated eyes in various strength sodium chloride solutions with and without the epithelium.

3. Determination of the swelling of excised corneas with and without the constituent membranes when the endothelial surface was bathed in distilled water and in 1 per cent and in 5 per cent sodium chloride solution and the epithelial surface was simultaneously bathed in sodium chloride solutions of progressively higher concentrations.

4. Determination of the swelling of corneas following immersion of whole enucleated eyes in various strength sodium chloride solutions with and without the epithelium and with several intraocular pressures.

These studies have shown that:

1. The degree of corneal hydration (turgescence) is largely controlled by differences in osmotic pressure between the inside and the outside of the cornea. (When excised normal corneas are bathed in solutions of sodium chloride with concentrations below approximately 1 per cent they imbibe water, but in solutions of greater concentration they lose water.)

2. These differences in osmotic pressure are made effective by intact epithelial and intact endothelial membranes, both of which are essentially impermeable to sodium chloride. (When excised corneas with either epithelial or endothelial damage are bathed in solutions of sodium chloride of any concentration tested up to 10 per cent, rapid and appreciable—250 per cent—swelling results.)

3. Pressure exerted intraocularly tends to oppose corneal swelling when swelling occurs as a result of disturbed osmotic relationships, but it does not appear that intraocular pressures within physiologic range have appreciable effect in preventing normal turgescence.

243 Charles Street.

CURE OF DEPRESSION OF LOWER LID FOLLOWING REINSERTION OF INFERIOR RECTUS MUSCLE

REPORT OF A CASE

JAMES A. INCIARDI, M.D.
BROOKLYN

A case of relief of depression of the lower lid following the reinsertion of an accidentally tenotomized inferior rectus muscle is presented here for several reasons. It demonstrates complications which could occur after an attempt at tenotomy of an inferior oblique muscle and puts one on guard when performing such an operation. Further, it presents a suggestion for management of future cases in which dysfunction of the lower lid is associated with or caused by a defect in the inferior rectus muscle.

ANATOMY

The inferior oblique muscle [1] arises from a shallow depression in the anteromedial corner of the floor of the orbit. It passes laterally and backward as a flat band beneath the inferior rectus muscle, to which it is united by its fascial sheath, and finally attaches to the posterolateral aspect of the globe. The inferior rectus muscle [1] runs above the orbital floor. As it crosses the inferior oblique muscle the sheaths of the two become associated to form the suspensory ligament of Lockwood. Where these two muscles cross their sheaths are closely joined and send an extension anteriorly, which attaches to the tarsal plate of the lower eyelid. The blending of these sheaths is marked by a special thickening, which extends upward, laterally and medially, to join the sheaths of the lateral and medial rectus muscles, thus giving indirect attachment to the orbital margins. In this way a continuous band forms underneath the globe, comprising the hammock-like suspensory ligament of Lockwood, which helps hold the eyeball in place. Associated with the expansion of the sheath of the inferior rectus muscle and inserted into the tarsal plate is the inferior palpebral muscle.

From this description one can see that a severed or defective inferior rectus muscle can, because of its relation to the tarsus and the suspensory ligament of the globe, interfere with the normal apposition of the lower lid to the globe and be responsible for a lagging of the lid, an ectropion

1. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1932, vol. 1, pp. 167, 168 and 181.

or a widening of the palpebral fissure. Furthermore, it is evident that an improper tenotomy of the inferior oblique muscle can give rise to deformities much greater than that which one is attempting to cure.

REPORT OF A CASE

V. M., a 16 year old white girl, was admitted to the clinic of Dr. Walter V. Moore at the Brooklyn Eye and Ear Hospital on July 30, 1940. She stated that she had had an operation for convergent squint in 1935, after which the left palpebral fissure became widened considerably and the left eye took a new position much higher than the right. Investigation revealed that a tenotomy of the left inferior oblique muscle had been performed at that time.

Examination showed that vision was 20/20 in the right eye with correction and counting of fingers at 2 feet (60 cm.), not improved with lenses, in the left. The muscles could not be examined with prisms because of poor fixation and extramacular fixation in the left eye. In the primary position there was 21 arc degrees of left hypertropia for distance and for near vision. This increased to 35 arc degrees in the lower fields and diminished to 14 arc degrees in the upper fields. The right palpebral fissure was 9 mm. in width and the left 16 mm. The remainder of the ocular examination and the physical survey were of no bearing. A diagnosis of double depressor paralysis with secondary depression of the lower lid and double elevator contracture in the left eye was made.

On Sept. 6, 1941 a reinsertion of the left inferior rectus muscle and a tenotomy of the left inferior oblique muscle were performed. Through a large, undermined, inferior conjunctival incision, Tenon's capsule was buttonholed and the inferior rectus muscle picked up. A thin flat strip of muscle was found attached to its stump. This strip was continuous, 8 mm. from the stump, with a dense sheet of fibrous tissue, which was strongly adherent both to the sclera beneath and to the capsule and conjunctiva above. The adhesions to overlying and underlying structures were separated. Dissection into the fibrous tissue mass revealed tissue of the inferior rectus muscle. This was continuous farther down with the usual course of the inferior rectus muscle. It was strong but inelastic. The muscle was picked up with two double-armed catgut sutures just beneath the point where it had been dissected free of fibrous tissue and sutured to the stump.

The temporal portion of the conjunctival incision was enlarged upward and the inferior oblique muscle picked up near its insertion. It was dissected free of capsule and sheath for several millimeters. The muscle was followed along its course and found to be strong, elastic and intact. Traction on it produced upward and inward rotation of the globe. It was divided completely close to its insertion.

On the patient's discharge from the hospital, September 13, there was a left hypertropia of 7 arc degrees in the upper fields and in the primary position. In the lower fields the deviation was 14 arc degrees. The right palpebral fissure was 9 mm. wide and the left 11 mm. The patient's appearance was considerably improved. When she was last seen, November 1, two months after operation, the findings were the same as on the date of discharge.

COMMENT

Since the inferior rectus muscle showed signs of having been severed and since the inferior oblique was intact, it was felt on reconstructing this case that the original deformity was paralysis of the superior oblique

muscle which caused a secondary contracture of the inferior oblique. At the first operation the inferior rectus muscle must have been mistaken for the inferior oblique and tenotomized As a result the lower lid became depressed and the superior rectus muscle developed a secondary contracture, giving the final picture of double depressor paralysis, double elevator secondary contracture and secondary depression of the lower lid. Because the vision in the left eye was so poor, a cosmetic result was all that was desired; consequently tenotomy of the inferior oblique muscle and reinsertion of the inferior rectus were performed in the hope not only of relieving some of the hypertropia but of diminishing the deformity of the lid.

From a consideration of the anatomy of the area involved and of the events in this case, it would be well to remember in performing a tenotomy of the inferior oblique muscle to keep away from the point where the inferior rectus and the inferior oblique muscles cross. Possibly tenotomy at the insertion might be the safest procedure. Furthermore, when a lagging of the lower lid is found, consideration should be given to congenital or acquired defects of the inferior rectus muscle.

2415 Beverly Road.

PITS, OR CRATER-LIKE HOLES, IN THE OPTIC DISK

JAMES N. GREEAR JR., M.D.
WASHINGTON, D. C.

In 1882 Wiethe reported a case of congenital deformity of the optic disk. His patient was a woman aged 62 who presented herself for examination because of glaucoma in the right eye. Examination of the left eye revealed vision of 20/30, normal color perception, tension and fields, and no scotoma present.

> Ophthalmoscopic examination showed papilla round, with a small flattening on the temporal side; but within its area were two black or olive-green depressions, with elliptical contours. . . . They were both in the substance of the optic nerve, near the scleral ring. One was situated at the nasal end of the horizontal diameter of the papilla, and had its long axis vertical; the other at the lower end of the vertical diameter of the papilla, with its longer axis horizontal. The first depression measured in its long axis ¼, and in its short axis ⅕ the diameter of the papilla. The dimensions of the second were, long axis ⅓ to ¼, short axis ⅕ diameters of the papilla. The bottom of the first was seen with —4½ D., corresponding to a depth of 0.84 mm. The bottom of the second was obscured by a delicate grayish veil, so that an accurate determination of its depth was not possible; nevertheless from the parallactic displacement of its edges in the inverted image, the condition of its surroundings and the course of the vessels, it was plainly shown that it was a depression, and not a simple pigmentation or elevation.

Wiethe stated the belief that this was a congenital deformity, since other congenital defects, such as pigmentation of the papilla, physiologic excavation and even coloboma of the sheath of the optic nerve, sometimes occur unilaterally. He pointed out that in the case in question the location on the disk of the deformity eliminated the possibility that the fetal fissure had anything to do with its origin. He called it the result of arrested development.

Since Wiethe's report, I have been able to find 69 similar cases in the literature, reported by fifty-three authors. Coats described the ophthalmoscopic appearance of a crater-like hole in the optic disk and reviewed the literature up to 1908, 16 cases having been reported. In 56 of the cases reported to date, the abnormality was in the temporal half of the papilla, usually in the lower quadrant, more rarely on the horizontal meridian and still more rarely in the upper quadrant (Makrocki, Herezogh, Tyson and Juhász-Schäffer). It was observed occasionally in the inner half of the disk (Wiethe, Remak, Prediger, Hillion and Nielsen), once at the lower edge (Wiethe) and four times in each eye

No.	Author	Date	Patient's Age and Sex	Eye Affected	Pit			
					Location	Size	Form	Depth
1	Wiethe	1882	62 ♀	L	One at nasal, one at inferior margin	Nasal, ¼ by ⅓ p. d.; lower, ⅓ to ¼ by ⅓ p. d.	Both elliptic	Nasal, 4.5 D.; lower, not precisely determinable
2	Remak	1884	26 ♀	R	Nasal half close to margin	.....	Cleft shaped	.....
3	Stood	1884	40 ♀	R	Temporal margin	.....	Vertical-oval	6 D.
4	Stood	1884	25 ♂	R L	Temporal margin	.....	.....	R, 9 D.; L, 7.5 D.
5	Gunn	1886	53 ♀	L	Outer part	.....	Round funnel shaped	.....
6	Randall	1887	15 ♀	R	Outer part	.....	.....	2 D.
7	Szili	1887	19 ♀	L	Lower lateral quadrant	⅓ p. d.	Approximately circular	Steep profundity, floor invisible
8	Makrocki	1889	.... ♀	R	Temporal half below horizontal diameter	⅓ temporal half	Oval	.....
9	Peltesohn	1888	.... ♀	L	External border	1/10 papillary area	Narrow perpendicular-elliptic with pointed ends	2 mm.
10	Rumschewitsch	1889	26 ♀	L	External quadrant	About ⅓ papillary area	Irregularly oval	Considerable depth
11	Makrocki	1890	.... ♂	L	Upper inner quadrant	Half the quadrant, i. e. ⅛ entire papilla	Circular-oval	About 1.2 mm.
12	Bock	1893	51 ♀	L	External lower quadrant	Involved entire external lower quadrant	.....	1.5 mm.
13	Dolganoff	1894	39 ♀	R L	R, center; L, external half	.....	R, funnel shaped; L, irregular	R, 4 D.; L, 3 D.
14	Ellett	1894	54 ♂	R L	.....	Both involved practically entire papilla	Round	1 D.
15	Szili	1901	41 ♀	R	Lateral margin of lower half	⅓ p. d.	Tapering oval	3 D.
16	Szili	1901	19 ♀	L	Lower temporal quadrant	⅓ p. d.	Round	.....
17	Dyckmeester	1903	49 ♀	R	Temporal margin of lower external quadrant	½ quadrant	Elliptic	.....
18	Thomson and Ballantyne	1903	.... ♂	L	Temporal half	⅓ p. d. in length	Vertically oval	.....
19	Bayer	1905	11 ♀	L	Lower external quadrant	Involved ¼-⅓ optic nerve	Round	Over 1 mm.
20	Lewinsohn	1906	.... ♀	...	Temporal margin	⅛ papilla (approximately)	.....	2.5 mm.
21	Lichtenstein	1907	53 ♂	L	Middle of temporal half	.....	Triangular	8 mm.
22	Herezogh	1908	14 ♀	...	Upper outer quadrant	Involved whole of quadrant	.....	1.5 mm. (approximately)
23	Lauber	1909	58 ♂	L	Lateral lower margin	Transverse diameter about ¼ p. d.	.....	About ¼ p. d.

Color	Function of Eye: (a) Vision	Function of Eye: (b) Visual Field	Macula	Comment (Causation)
Blackish shading to olive green	20/30	Normal, no scotoma	.....	Arrest of development; other eye exhibited symptoms of mild inflammatory glaucoma
Intense bluish white	Normal with slight hypermetropia	Slight concentric narrowing	.....	.....
Bluish white	20/20 with +1 D. sph.	Paracentral scotoma between fixation point and blindspot	.....	Congenital malformation
.....	R, 6/9; L, 6/36	Normal	.....	Congenital malformation; right eye, choroidal coloboma inferiorly from the papilla
Dark green	6/36; with +2 D. sph., 6/6, fairly	.....	.....	Arrest of development; probably allied to coloboma of optic nerve sheath
Grayish	Normal	.....	.....	.....
Blackish gray, with lighter spot	6/9	Normal	.....	.....
Bluish white shining spot	5/6; hypermetropia	Slight narrowing in upper part on both sides	.....	.....
Dark blue-gray	20/20; slight hypermetropia	Normal	.....	.....
Bluish white	Fingers counted at 50 cm.; hypermetropia, 4.5 D.; divergent strabismus	Not narrowed	.....	.....
.....	6/18; hypermetropia	Central color perception normal	.....	.....
In inverted image, white gray, almost black	6/24; slight hypermetropia	.....	.....	.....
Dazzling white	R, 20/20, and L, 20/20, with glasses	Limits of visual field normal for all colors	.....	.....
.....	Normal	Normal	.....	Congenital (physiologic?) excavation
.....	3/70	.....	.....	Bilateral idiopathic optic nerve atrophy
Blackish gray	6/10	Normal	.....	.....
Dark blue with greenish tint, a little lighter in center	6/6; hypermetropia, 3 D.	Normal	.....	.....
Gradation of shading from periphery to center	6/6; myopia, 6 D.	.....	.....	.....
Gray-black	6/6; slight hypermetropia	Normal	.....	Circumscribed defect in nerve substance probably involved
.....	1	Normal	.....	.....
Greenish glimmering walls	6/6 with —0.75 D. sph.	.....	.....	Congenital deformity
.....	6/10; emmetropia	Normal	.....	Congenital formation
Gray	.....	Paracentral scotoma	.....	Congenital coloboma in form of a hole

No.	Author	Date	Patient's Age and Sex	Eye Affected	Pit			
					Location	Size	Form	Depth
24	Mohr	1908	42 ♀	L	Lower outer quadrant	⅛ papilla	Oval	.....
25	Reis	1908	47 ♂	R	Close to temporal margin	⅛ papillary area	Circular	More than
26	Reis	1908	43 ♂	L	Close to temporal margin	⅛ papillary area	Perpendicularly oval	At least 4 D.
27	Reis	1908	30 ♂	R	Temporal half	⅓ papillary area	Irregularly circular	At least 4 D.
28	Reis	1908	60 ♂	R	Temporal margin	⅛ papillary area	Circular	7 D.
29	Reis	1908	.... ♀	L	Close to temporal margin	⅛-⅓ papillary area	Vertically oval	At least 5 D.
30	Carr	1909	12 ♀	L	Close to temporal-inferior border	.....	Oval rather than circular	About 3 D.
31	Frenkel	1909	18 ♀	L	Temporal half	⅓ p. d.	Circular	Not more than 9 D. at any point
32	Lauber	1909	32 ♀	L	Temporal margin	.....	Circular	.....
33	Lauber	1909	43 ♀	L	Lower-temporal margin	⅔ p. d. high, ¼ p. d. wide	.....	.....
34	Lauber	1909	58 ♂	L	Lower-temporal margin	About ¼ p. d. wide	.....	.....
35	Lauber	1909	44 ♀	L	Lower external quadrant	.....	.....	2 D.
36	Lauber	1909	29 ♀	...	Temporal ⅔ of papilla involved in large physiologic excavation; pit close to temporal margin of papilla	.....	.....	.....
37	Prediger	1909	12 ♀	R	Two pits, one below the other, in nasal half and close to margin	Lower, size of pea; other, slightly smaller	Round	Lower, 5 D.; upper, 9 D.
38	Stephenson	1909	10 ♀	R	Two excavations on outer side	.....	One polygonal, other semicircular	.....
39	Gebb	1910	16 ♂	R	Temporal half	Involved about ¼ horizontal papillary diameter	.....	.....
40	de Schweinitz	1911	14	R	Upper half	Large	.....	3 D.
41	Hillion	1911	29 ♂	R L	Left, nasal side; right, temporal side	Very large on left, less so on right	.....	.....
42	Randall	1911	15 ♀	L	One at each lateral margin	.....	.....	.....
43	Crampton	1913	20 ♂	R L	.....	Involved whole disk on R, central portion on L	Both round	.....
44	Crampton	1913	5 ♀	R L	.....	Involved whole disk on both sides	Both round	.....
45	Naimushin	1912	.... ♂	R	Lower temporal quadrant	⅛ p. d.	Oval	.....

Optic Disk—Continued

Color	Function of Eye		Macula	Comment (Causation)
	(a) Vision	(b) Visual Field		
Dark green, a little lighter at center	5/10 ; with +1.00 D. sph., 5/7	Normal	.....	.....
Olive green	6/6 ; slight hyperopic astigmatism	Normal	.....	.....
Dull gray	2/3 ; slight hypermetropia	Normal	.....	.....
Pale olive	15/200	.....	Hole formation in macula lutea from previous exudative-hemorrhagic papilloretinitis	.....
Pale dark greenish	1/500	.....	.....	Extensive old disseminated chorioretinitis
Greenish gray	6/6 with —2.5 D. sph.	Normal	.....	Other eye affected with severe congenital amblyopia
Gray-green	6/8	Normal	.....	.....
Extremely dark, markedly pigmented	1/6 with —7 D. sph.	Normal	.....	.....
Greenish gray	5/10 with —3 D. sph.	Normal	.....	Papilla embraced by a broad underlying conus lightly flecked with gray
Light gray-blue with gray-green walls	6/6 with +3 D. sph.	Normal	.....	Papilla embraced by an underlying conus ⅓ p. d. wide
Gray tending a little toward green	8/10 ; emmetropia	Irregularly shaped absolute scotoma	.....	.....
Floor bluish white ; lowest third dark gray, almost black	5/6 with 0.5 D. sph.	Extended absolute scotoma	.....	.....
Gray, pale greenish	Hypermetropia, 0.5 D.	.....	.....	Patient died of puerperal sepsis one day after admission to hospital ; globe enucleated and studied post mortem
Whitish gray	6/6	Normal	.....	Congenital deformities
Greenish	6/9	.....	.....	.....
Gray-green to porcelain white (with focusing of —3 D. to —14 D.)	Normal	.....	.....	Patient had dementia praecox
.....	6/7.5 after correction of hyperopic astigmatism	.....	.....	.....
Clear to dull white	R, 1, L, 0.9, with correction	Normal	.....	.....
Dark greenish	6/5	Normal	.....	.....
.....	R., poor central light perception ; L, uncorrected, 6/9	.....	.....	.....
.....	R, no light perception ; L, 6/9 to 6/12 by object tests	Impossible to determine visual fields satisfactorily	.....	.....
Dark gray	6/10	Normal		

No.	Author	Date	Patient's Age and Sex	Eye Affected	Pit — Location	Pit — Size	Pit — Form	Pit — Depth
46	James	1913	6 ♂	L	Temporal side below horizontal meridian	About 1/10 papillary area	Round	.....
47	Williams	1913	9 ♀	R	Lower outer quadrant	¼ quadrant	Oval	About 4 D.
48	Henderson	1914	11 ♀	L	Inferior temporal quadrant	.....	.....	.....
49	Holloway	1915	19 ♂	L	Lower outer quadrant	⅓ p. d.	Oval	.....
50	Claiborne	1916	18 ♀	R	Temporal side	.....	Oblong	3 D.
51	Köhne	1916	23 ♀	L	Close to temporal margin	About 1/7 p. d. in width	.....	Approximately 2 D.
52	Harwood	1918	28 ♂	R	Temporal side just below center	.....	Triangular	.....
53	Stargardt	1919	30 ♂	...	Optic nerve entrance	.....	.....	5-7 D.
54	Van Duyse and Van Lint	1920	30 ♂	R	External portion	Involved about ⅛ papilla	Oval	.....
55	Van Duyse and Van Lint	1920	....	R L	Inferior-lateral portion of both disks	.....	Both oval	.....
56	Carsten	1924	.... ♀	L	External third	⅛ entire papilla	Oval	About 3 D.
57	Nielsen	1924	12 ♀	R	One on temporal, one on nasal side	⅛ disk	.....	.....
58	Abramowicz	1926	25 ♂	L	One nasal, one temporal	⅛ and ⅙ p. d.	.....	Nasal, 3 D.; temporal, 5 D.
59	Abramowicz	1926	21 ♂	R	Temporal margin	⅛ p. d.	.....	5 D.
60	Abramowicz	1926	55 ♂	L	Upper-temporal margin	¼ p. d.	.....	7 D.
61	Tyson	1927	77 ♀	R L	Left, superior third; right, temporal side	.....	Both oval	Between 9 and 10 D. in left disk
62	Calhoun	1930	10 mo. ♀	R	Lower margin	About ⅓ p. d.	Semi-elliptic	Uncertain
63	Edmund	1930	19 ♀	R	Temporal half	Entire half	Vertically oval	Maximum, 3 D.
64	Edmund	1930	50 ♂	L	Lower-outermost region	About 0.3-0.4 p. d.	Horizontally oval	About 3-4 D.
65	Yoshida	1931	....	...	Temporal margin	¼ p. d.	.....	5 D.
66	Juhász-Schäffer	1933	52 ♂	R	Superior nasal sector	⅛ breadth of papilla	Circular	5 D.
67	Juhász-Schäffer	1933	47 ♂	L	Middle of superior temporal sector	1/7 papilla	Circular	.....
68	Moffatt	1934	70 ♀	R	Lower temporal quadrant	About ¼ p. d.	Roughly circular	.....
69	Löwenstein	1936	35 ♀	L	.....	.....	.....	.....
70	Greear	1941	73 ♂	R	Temporal margin	⅛ p. d.	Circular	.....
71	Greear	1941	27 ♀	L	Temporal margin	⅛ p. d.	Oval	4 D.
72	Greear	1941	40 ♂	R	Lower temporal quadrant	⅓ p. d.	Oval	5 D.

Optic Disk—Continued

Color	Function of Eye: (a) Vision	Function of Eye: (b) Visual Field	Macula	Comment (Causation)
Slaty blue	Slight	.....	Central part dull yellow, with massing of fine pigment around edge	.....
Dark greenish	5/6 with correction	.....	Granular erosion in and about each macula	.....
.....	6/9 with correction of some myopic astigmatism	.....	.....	.....
Greenish black	6/5 with +0.62 D. cyl., axis 120	.....	.....	.....
.....	.....	.....	.....	.....
Silver gray to bottle green to brownish	Poor	.....	.....	.....
.....	20/200	.....	.....	.....
.....	Relatively good	Normal	.....	Congenital anomaly
Gray-white	1/10; excentric	Normal	.....	Slight absolute central scotoma caused by relatively extensive choroidal hemorrhage into macula
Blackish	Both eyes hyperopic, with normal (6/10) vision	Normal	.....	Congenital anomaly
Slate gray	5/8	Normal	.....	Congenital deformity
Dark olive gray	6/5	Normal	.....	.....
Gray-green	1/10	Concentric narrowing	.....	.....
.....	5/100	Contraction	.....	.....
Dark	8/10	Normal	.....	.....
Slaty blue (L)	R, 20/50; L, 5/200	Normal (R)	Macular choroiditis (L)	Bilateral ocular arteriosclerosis
Dirty gray	.....	.....	Normal	.....
.....	6/60 corrected	Normal	.....	.....
Diffusely grayish	6/9	.....	.....	Congenital formations
Pale blue	.....	Enlargement of blindspot	.....	.....
Gray	1.25	Normal	.....	.....
.....	Normal	Normal	.....	.....
Grayish	6/12 corrected	.....	.....	Right blindspot enlarged and continuous, with a paracentral scotoma
.....	.....	.....	.....	Pulsating gray cloud protruding from pit
Slaty gray	20/20—1	Centrocecal scotoma	Normal	.....
Gray	20/20—2	Sector defect continuous with blindspot	Normal	.....
Gray	20/30	Centrocecal scotoma	Normal	.....

(Dolganoff, Hillion, Randall and Tyson). Two pits in the same disk were reported by Wiethe, Prediger, Stephenson, Nielsen and Abramowicz.

In none of the cases reported did the pit extend beyond the edge of the papilla, which was usually normal in shape, although occasionally the disk was expanded eccentrically in the direction of the abnormality. The opening was usually oval, the long axis being concentric with the disk margin. However, it may be circular, oblong, triangular, polygonal, semicircular or slitlike. The central vessels usually had their normal arrangement but might be slightly displaced toward the nasal side. Often when one of the retinal vessels happened to cross the pit it dived into it, to reappear on the farther side; occasionally a vessel emerged from the pit. The edge was usually sharp, and the cavity commonly was directed straight back into the nerve. However, it might be oblique. The depth varied from very shallow to as much as 26 D., that is 8 to 9 mm. The floor might be fairly clear or might appear to be covered with a soft gray veil. The size was usually between one-eighth and one-third the diameter of the disk. In exceptional cases the pit occupied a whole quadrant of the disk. In rare instances there were other congenital anomalies present in the same eye. A small paracentral scotoma was occasionally found. The color has been described as black with a shade of olive green, dark blue-gray, bluish white, dark green, blackish gray, slaty gray, gray-black, dark with a shade of green, dull gray and olive-green.

The relative infrequency of the condition was emphasized by Reis, who noted 5 cases among 55,000 patients with ocular complaints.

Holloway reported a case of hole in the disk associated with vibration of an overlying membrane. There was pulsation of a small milky area situated somewhat eccentrically up and in from the center of the lesion, the direction of the pulsation being in the long axis of the hole. In the cases of Wiethe, Reis, Stephenson and Löwenstein, a gray veil was present, as in the case Holloway described. Holloway explained the pulsation on the ground that the central vessels might lie in a more intimate relation with the walls of the excavation and that the pulselike appearance was produced by an impulse transmitted by the overlying vessels to the central membrane.

Calhoun reported a case of pit in the optic disk associated with coloboma of the disk and called attention to the fact that these two conditions had rarely been found associated. The cavity behind the level of the papilla contained fragments of altered retinal tissue and some pigmentation suggesting pigment epithelium. He also stated: "True coloboma of the optic nerve . . . is one of the rarest of congenital anomalies, and a correct diagnosis cannot be made without a histologic study, and even then there is often confusion."

ETIOLOGY

Wiethe stated the belief that the condition was a congenital deformity. In the case reported the position of the pits eliminated the fetal cleft as a possible factor in its production. Wiethe expressed the opinion that the deformity was an arrest of development.

Coats said that a "crater-like hole in the papilla arose by the evagination of a portion of the secondary optic vesicle into the nerve, or more possibly by the abnormal differentiation of a part of the neural division of the vesicle into pigment epithelium and retinal elements." He emphasized the fact that such an abnormality had no necessary connection with the fetal cleft.

Stephenson stated that there was a general tendency among authors to regard the anomaly as an incomplete coloboma of the disk.

Claiborne expressed the opinion that the defect in his case was a partial coloboma of the optic disk.

Wessely advanced the belief that the pits represented vessel funnels of cilioretinal vessels the contents of which had partially or entirely disappeared.

Halbertsma called attention to the difference of opinion among the older authors as to the origin of the anomaly. Wiethe in 1882, Stood in 1884, Remak in 1884, Szili in 1887 and Reis in 1908 on the whole considered the process to be a colobomatous one. Halbertsma expressed the opinion that the abnormal growth of the retinal tissue resulted in the disk's becoming colobomatous and assumed the defect to be an atypical coloboma.

In opposition to many views previously expressed, Szili arrived at the conclusion that the conception of "hole formations as partial colobomas" is inadmissible because the pits have nothing to do with the optic cleft but are to be regarded as a remnant of the cavity of the optic cup stalk. He stated that the ophthalmologist should never expect to be able from the ophthalmoscopic image alone to determine positively the degree and the type of underlying disturbance in the nerve.

Seefelder expressed the opinion that there may be involved an abnormal persistence and perhaps a secondary enlargement of the cavity of the embryonal optic nerve bounded by the inner wall of the stalk whereby the formation of an optic nerve papilla is prevented.

PATHOLOGY

In a review of the pathologic process of coloboma at the nerve entrance, Coats stated:

> In the vast majority of defects at the nerve entrance, as in colobomata elsewhere, the rule holds that the abnormality occurs in the line of the foetal cleft, but the neural and intraocular portions of the cleft are directly continuous with

one another and any hard and fast distinction between defects of one or the other portion, though for certain purposes convenient, is to some extent artificial.

He was able to find reported in the literature only 3 unequivocal examples in which the lesion was a coloboma of the nerve alone, the adjoining choroid being normal. He examined pathologically the eyes secured from an anencephalic child which was born at full term and lived thirty-six hours. No ophthalmoscopic examination was made. He found a deep pit exactly at the edge of the papilla filled with loose retinal elements which would probably be almost transparent on ophthalmoscopic examination and might give the appearance of the soft gray veil described by Wiethe and others. The cavity ran straight back into the nerve, and the diameter was about one-third the diameter of the nerve entrance. The walls and the floor were lined with pigment epithelium.

Lauber (1909) made the first anatomicopathologic report on a case of pit formation in which the pit was verified also ophthalmoscopically. Lauber commented, "Briefly summarized, the case represents, anatomically, an evagination of the pial sheath containing retinal elements." He stated the belief that this anomaly should be included among the various colobomatous formations of the optic nerve and its sheath. In his case many of the retinal elements which filled the coloboma could be identified, including pigment epithelium, neural epithelium and pigment epithelial cells without pigment. Glial tissue and nerve elements filled the floor of the pit. He concluded: that (1) circumscribed gray flecks or spots in the optic nerve entrance represent partial colobomas, (2) the coloration depends on a contrast and shadow effect and not on pigmentation, (3) occasionally they are associated with inferior conus and resemble closely this malformation and (4) sometimes they produce paracentral scotomas and simultaneous peripheral contraction of the visual fields.

Seefelder concluded with Lauber that pit formations of the optic papilla are, in accordance with their previously undoubtedly incomplete anatomicopathologic knowledge, to be classified among colobomatous changes at the optic nerve entrance. Seefelder found on the medial side of the optic nerve, at some distance from the surface of the papilla, an insulariform infiltration of rudimentary retinal tissue and pigment epithelium into the pial sheath of the optic nerve which became gradually larger from top to bottom and finally joined the optic nerve itself. The following elements were distinguishable in the tissue of the pouch: (1) nerve fibers, (2) glial tissue with the appearance of rudimentary retina, (3) pigment epithelium and (4) vessels. The pouch consisted chiefly of

tissue, with the appearance of rudimentary retinal tissue, which was everywhere traversed by strong, irregularly dispersed glial fibers. The lamina cribrosa bent slightly upward in a backward direction at the transition of the tissue of the pouch into the optic nerve, while in the region of the pouch it was entirely absent.

In the case reported by Calhoun, the pouch corresponding to the hole, or crater, seen ophthalmoscopically on the disk was partially filled or lined with pigment, retinal elements and debris. No definite trace of the lamina was observed. The pial covering below formed the inner wall of the pit, the outer wall of which was composed of dura.

REPORT OF CASES

CASE 1.—J. F., a white man aged 73, was first examined March 2, 1939. He was referred for an examination of his eyes because of a persistent vertical diplopia

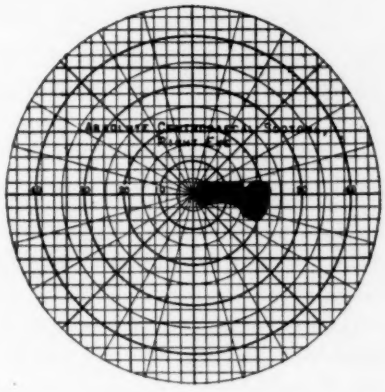


Fig. 1 (case 1).—Central field of the right eye with a 2 mm. object (March 2, 1939).

for a period of one week. He had some muscular soreness in his arms after the onset of this diplopia. He had been given glasses both for distant and for near vision but wore them for near work only. Several months before examination he discovered that there was a blur to the temporal side of the point of fixation in the right eye. He had known for several years that he had high blood pressure. There was a moderate degree of sclerosis of his peripheral arteries. The Wassermann and the Kahn reaction were negative. Urinalysis gave negative results. The blood pressure was 210 systolic and 115 diastolic, and there was mild cardiac enlargement.

Vision in the right eye was 20/40, improved to 20/30. Vision in the left eye was 20/40, improved to 20/20, with 5 D. of right hyperphoria at 20 feet (6 meters) and 4 D. of right hyperphoria at 13 inches (33 cm.). Diplopia plotting revealed

a mild paresis of the right superior oblique muscle. The intraocular tension (Schiøtz) was 20 mm. of mercury in each eye.

Fundus Examination.—Right Eye: There were a few floating opacities in the vitreous; otherwise the media were clear. The disk margins were sharply defined. There was rather wide physiologic cupping of the disk. Off the temporal margin was a small area of choroidal atrophy from 8 to 9:30 o'clock. There was a faint line of choroidal pigment along the disk margin from 9 to 10 o'clock. To the temporal side of the disk and extending to the margin from about 8 to 9 o'clock was a slaty gray circular area which appeared to be excavated. One could not focus sharply into the depth of this punched-out area, since it appeared to pursue a somewhat oblique course. It presented a distinctly blue-gray appearance, in contrast to the normal appearance of the remainder of the nerve head. The retinal arteries were somewhat attenuated, with some irregularity of the lumens. The veins were normal in appearance. There was mild arteriovenous compression. The macular region appeared normal. No other changes were noted throughout the fundus.

Left Eye: There was an occasional floating opacity in the vitreous. The disk was normal in appearance. The vessels were as described in the right eye.

Fields of Vision.—The form fields were normal for the right eye with a 3 mm. object. Examination of the central field revealed a centrocecal scotoma extending almost to the point of fixation. No other scotoma was found. The blindspot was normal in the left eye, with no scotoma present.

Case 2.—Mrs. J. C., a white woman aged 27, was first examined on Feb. 7, 1936. Her chief complaint was an inflammation of the left eye which had been present for two weeks without pain or discomfort. She stated that she had worn glasses for the past year for near work only. She had occasional headaches associated with the use of her eyes, but she had not been conscious of any visual disturbance in either eye. There was no lacrimation or photophobia. Her general health had always been good, she had never had a serious ocular disturbance and there was no family history of diseases of the eyes.

Vision was 20/20 in the right eye and in the left was 20/30, improved to 20/20 — 1. The patient had normal muscle balance, both for distance and for near vision. Her accommodation was normal and was equal in the two eyes. Color vision was normal in each eye (Stilling). The intraocular tension (Schiøtz) was 19 mm. of mercury in each eye.

Fundus Examination.—Right Eye: The media were clear, and the disk was pink and sharply defined and had a fairly large physiologic cupping. The vessels and the macula were normal in appearance.

Left Eye: The media were clear. There was rather marked cupping of the disk, with vessels disappearing over the margin to reappear in the bottom of the cup. The disk margin was pink to the nasal side from 8 to 1 o'clock. From 1 to 8 o'clock on the temporal side the cupping extended to the margin. The lamina cribrosa could be faintly made out in the bottom of the cup. To the temporal

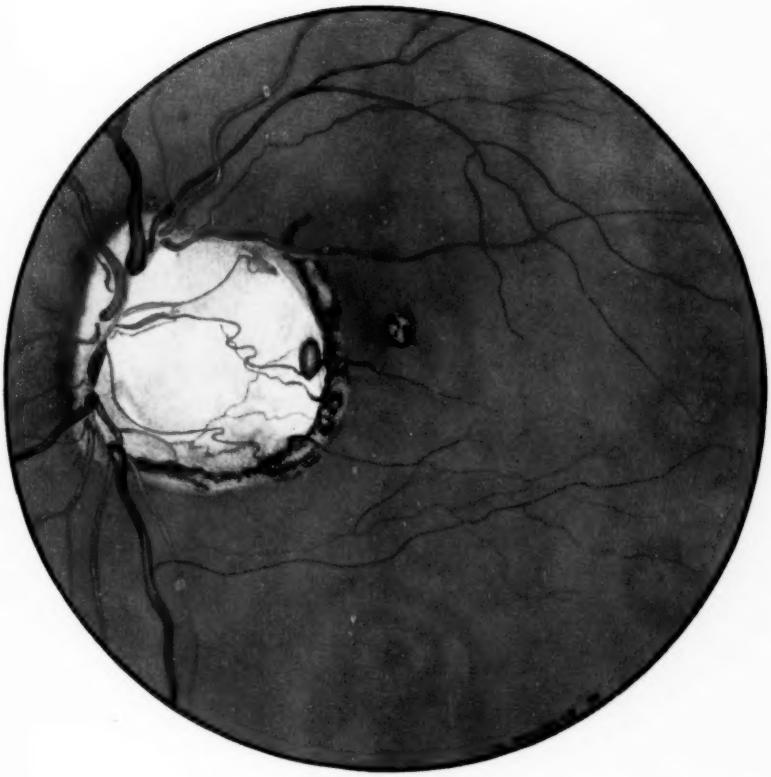


Fig. 2 (case 2).—The left fundus, showing the pit to the temporal side of the disk.

side of the disk and extending to its margin at 3 o'clock was a small oval excavation which presented a slaty gray appearance, its diameter being about one-eighth to one-tenth that of the disk. A small vessel passing across to the temporal side of the disk traversed the lower margin of the area described, dipping into the excavation for a considerable distance. One could focus for 4 D. into the opening, and the bottom presented a much lighter gray area than when one focused on the surface. To the nasal side of the disk was a small crescent of choroidal atrophy, with slight pigmentation along the disk margin. Temporal to this was a small area of choroidal atrophy. The retinal vessels and the macular area appeared normal.

Fields of Vision.—The fields of the right eye were normal for both form and colors. In the left eye there was a large scotoma continuous with the blindspot, extending to the periphery above and passing to within 5 degrees of the point of fixation.

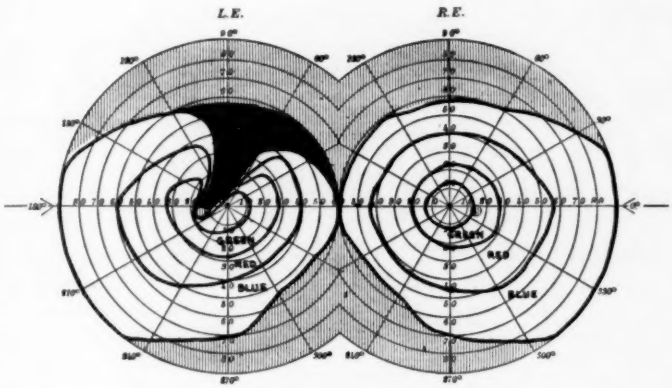


Fig. 3 (case 2).—The visual fields Sept. 30, 1939 with a 3 mm. white and 5 mm. colored objects.

CASE 3.—H. P. B., a white man aged 40, was seen by a colleague, Dr. LeRoy W. Hyde, on Aug. 23, 1927. He was an electrical engineer and had always been conscious of some disturbance of vision in the right eye. Except for blurring, he had had no trouble. He had a moderate degree of myopia, and his vision was corrected to 20/30 in the right eye and 20/15 in the left eye. However, at times vision in the right eye fluctuated from 20/30 to 20/40. The fundus picture had remained unchanged. The pupils were equal and reacted normally.

Fundus Examination.—Right Eye: There was an occasional floating opacity of the vitreous. The disk was slightly oval horizontally and appeared somewhat larger than normal. The nasal margin was pink. The temporal two thirds of the disk was somewhat pale but essentially normal in appearance. There was choroidal pigment from 12 to 3 o'clock. The vessels emerged somewhat to the nasal side. To the temporal margin of the disk was a gray excavation extending from

9 to 6:30 o'clock. This area was slightly oval in shape, with its long axis almost horizontal. Its longest diameter was about one-third the diameter of the disk. It was difficult for one to focus on the base of this excavation, but what appeared to be the bottom of it could be seen about 5 D. below the surface of the disk. A small vessel crossing the disk from the point of entrance of the central vessels dropped over the margin of the pit and emerged again near the disk margin. There were no other vessels seen in the pit. Its temporal edge extended completely to the periphery of the disk margin. The remainder of the fundus appeared perfectly normal.

Left Eye: Fundus examination of the left eye revealed no gross pathologic change.

Fields of Vision.—The form fields were normal for each eye with a 3 mm. object. Examination of the central field of the right eye revealed a centrocecal scotoma extending to within about 1 degree of the point of fixation. The central field of the left eye revealed no changes.

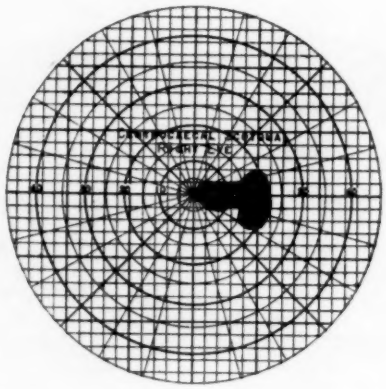


Fig. 4 (case 3).—Central field of the right eye with a 1 mm. object (May 24, 1941).

COMMENT

Pit, or crater-like hole formation, in the optic disk is a relatively rare congenital anomaly. This fact was emphasized by Reis, who reported 5 cases among 55,000 patients with ocular complaints. Furthermore, no mention was made of it for about thirty years after the ophthalmoscope came into use. I, personally, have observed only 3 cases in an active practice extending over a period of eighteen years. Central field changes were present in the 3 cases included in this paper, and there were peripheral field changes in one of these. The term coloboma indicates that type of congenital anomaly wherein a portion of a structure of the eye is lacking, and typical colobomas occur as a result of disturbance of closure of the fetal fissure. Congenital defects of a similar appearance but of different causation are termed atypical colobomas. Therefore, it would seem that pits, or crater-like holes, of the disk should be classified under the latter heading. In all cases studied pathologically, pigment epithelium

has been present in the pit, or hole. Hence no further explanation for the ophthalmoscopic appearance of the excavation seems necessary, although it might be the result of contrast or shadow in some instances.

1740 M Street Northwest.

BIBLIOGRAPHY

Abramowicz, I.: Circumscribed Holes in Optic Nerve Papilla, Klin. oczna **4**: 15-20, 1926.

Bayer, F.: Ueber Kolobom des Sehnerven, Cor.-Bl. d. Ver. deutsch. Aerzte in Reichenberg **18** (no. 11):1, 1905.

Bock, E.: Die angeborenen Kolobome des Augapfels: Eine anatomische und klinische Studie, Vienna, J. Safar, 1893.

Calhoun, F. P.: Bilateral Coloboma of Optic Nerve Associated with Holes in the Disk and a Cyst of the Optic Sheath, Arch. Ophth. **3**:71-79 (Jan.) 1930.

Carr, T. E. A.: Note on a Case of "Hole in the Optic Disc," Ophthalmoscope **7**:742, 1909.

Carsten, P.: Ueber umschriebene Grubenbildung auf der Sehnervenpapille, Ztschr. f. Augenh. **54**:79-81, 1924.

Claiborne, J. H.: Hole in the Disc, Ann. Ophth. **25**:299, 1916.

Coats, G.: The Pathology of Coloboma at the Nerve Entrance, Roy. London Ophth. Hosp. Rep. **17**:225-231, 1907-1908.

Crampton, G. S.: Two Cases of Binocular Coloboma of the Optic Nerve in the Same Family, Tr. Am. Ophth. Soc. **13**:461-468, 1913.

de Schweinitz, G. E.: Anomalous Excavation of the Optic Disk, Ann. Ophth. **20**:673, 1911.

Dolganoff, W.: Ein seltener Fall einer tiefen physiologischen Excavation, Arch. f. Augenh. **28**:348-350, 1893-1894.

Dyckmeester, cited by Reis.

Edmund, C.: On Congenital Colobomatous Groove Formations in the Optic Disk, Acta ophth. **8**:56-63, 1930.

Ellett, E. C.: A Case of Unusually Extensive Congenital Excavation of the Optic Nerve, Ophth. Rec. **4**:99, 1894.

Frenkel, A.: Sur les cavités partielles de la papille du nerf optique, Ann. d'ocul. **141**:101-110, 1909.

Gebb, H.: Ueber der Gefässverlauf im Bereich einer umschriebenen Grubenbildung des Sehnervenkopfes, Arch. f. Augenh. **67**:278-280, 1910.

Gunn, R. M.: Peculiar Deep Partial Excavation of the Optic Disc, Tr. Ophth. Soc. U. Kingdom **6**:374, 1886.

Halbertsma, K. T. A.: Crater-Like Hole and Coloboma of Disc Associated with Changes at Macula, Brit. J. Ophth. **11**:11-17, 1927.

Harwood, C. B.: Case of Hole in Disc, Am. J. Ophth. **1**:572, 1918.

Henderson, E. E.: Crater-Like Hole on the Disk, Proc. Roy. Soc. Med. (Sect. Ophth.) **7**:8, 1913-1914.

Herezogh, I.: A Typical Excavation of the Optic Nerve, Szemészet **45**:212, 1908.

Hillion, H.: Vaste excavation physiologique de la papille, Arch. d'opht. **31**:247-249, 1911.

Holloway, T. B.: Hole in the Disc Associated with Vibration of an Overlying Membrane, Ophth. Rec. **34**:250-253, 1915.

James, R. R.: Crater-Like Hole in the Disc Associated with Changes at the Macula, Ophth. Rev. **32**:38-40, 1913.

Juhász-Schäffer, A.: Umschriebene Grubenbildung des Sehnervenkopfes, Ztschr. f. Augenh. **81**:314-318, 1933.

Köhne, W.: Umschriebene Grubenbildung im Bereich eines Koloboms am Sehnerveneintritt, Ztschr. f. Augenh. **36**:212-216, 1916.

Lauber, H.: Klinische und anatomische Untersuchungen über lochförmige partielle Kolobome des Sehnerven, Ztschr. f. Augenh. **21**:494-504, 1909.

Lewinsohn, G.: Eine lochförmige Aushöhlung innerhalb der sonst völlig normalen rechten Papille, Centralbl. f. prakt. Augenh. **30**:75, 1906.

Lichtenstein, cited by Reis.

Löwenstein, A.: Eine noch nicht beschriebene Erscheinung im Glaskörper bei angeborener Grubenbildung im Sehnervenkopf, Klin. Monatsbl. f. Augenh. **97**: 607-611, 1936.

Makrocki, F.: Ein Fall von Canalis Cloqueti und Coloboma nervi optici, Arch. f. Augenh. **21**:29-41, 1889-1890.

Zur Kenntnis der atypischen Sehnerven-Excavation, Arch. f. Augenh. **22**:381-392, 1890-1891.

Moffatt, P. M.: Hole in the Disc, Proc. Roy. Soc. Med. **27**:300, 1934.

Mohr, M.: Typical Excavation of the Papilla, Szemészet **45**:213, 1908.

Naimushin, N.: Partial Coloboma of Optic Nerve, Vestnik oftal. **29**:795, 1912.

Nielsen, J.: Pits on the Optic Disc, Acta ophth. **2**:291-293, 1924-1925.

Peltesohn, N.: Zur Morphographie der Papilla optica, Centralbl. f. prakt. Augenh. **12**:339-341, 1888.

Prediger, H.: Ein Fall von angeborener umschriebener Grubenbildung an der Papille, Ztschr. f. Augenh. **21**:308, 1909.

Randall, B. A.: Coloboma of the Optic Nerve and Sheath, Tr. Am. Ophth. Soc. **4**:558-564, 1887.

Randall, A.: A Double Coloboma (Nasal and Temporal) of the Optic Nerve and Sheath: Exhibition of Drawing, Tr. Am. Ophth. Soc. **12**:968-971, 1909-1911.

Reis, W.: Eine wenig bekannte typische Missbildung am Sehnerveneintritt: Umschriebene Grubenbildung auf der Papilla nervi optici, Ztschr. f. Augenh. **19**:505-528, 1908.

Remak: Ein Fall von Colobom der Sehnerven, Centralbl. f. Augenh. **8**:225-229, 1884.

Rumschewitsch, K.: Zur Morphographie der Papilla nervi optici, Centralbl. f. prakt. Augenh. **13**:134-138, 1889.

Seefelder, R.: Die angeborenen Anomalien und Missbildungen des Auges, Ergebn. d. allg. Path. u. path. Anat. **16**:435-535, 1914.

Ein pathologisch-anatomischer Beitrag zur Frage der Kolobome und umschriebenen Grubenbildungen am Sehnerveneintritt, Arch. f. Ophth. **90**:129-137, 1915.

Die angeborenen Anomalien und Missbildungen des Auges, Ergebn. d. allg. Path. u. path. Anat. **21**:511-629, 1927.

Stargardt: Ueber eine Missbildung am Sehnerveneintritt (Grubenbildung), Deutsche med. Wchnschr. **45**:1374, 1919.

Stephenson, S.: Crateriform Hole in the Optic Disc, Ophthalmoscope **7**:78, 1909.

Stood, W.: Zur Casuistik der Missbildungen an der Sehnervenpapille, Klin. Monatsbl. f. Augenh. **22**:285-294, 1884.

Szili, A.: Zur Morphographie der Papilla nervi optici, Centralbl. f. prakt. Augenh. **9**:1-6, 1887.

Augenspiegel-Studien zu einer Morphographie des Sehnerven-Eintrittes im menschlichen Auge, Wiesbaden, J. F. Bergmann, 1901.

Thomson, W. E., and Ballantyne, A. J.: Congenital (? and Hereditary) Development of Choroidal Tissue in the Optic Nerves of Two Brothers, Tr. Ophth. Soc. U. Kingdom **23**:276, 1902-1903.

Tyson, H. H.: Crater-like Cavities in Optic Disc, Am. J. Ophth. **10**:239-240, 1927.

Van Duyse, D., and Van Lint, A.: Les excavations atypiques colobomateuses de la papille, Arch. d'opht. **37**:155-162, 1920.

Wessely, K.: Stehen die angeborenen umschriebenen Grubenbildungen in der Papille genetisch in Beziehung zu opticociliaren bezw. cilioretinalen Gefässanastomosen? Arch. f. Augenh. **65**:98-102, 1909-1910.

Wiethe, T.: Ein Fall von angeborener Difformität der Sehnervenpapille, Arch. f. Augenh. **11**:14-19, 1882.

Williams, C.: Hole in the Disc, Ann. Ophth. **22**:638-640, 1913.

Yoshida, Y.: Case of Pit Formation at the Optic Nerve Papilla, Acta Soc. ophth. jap. **35**:1391-1400, 1931.

USE OF PADGETT DERMATOME IN OPHTHALMIC PLASTIC SURGERY

BYRON SMITH, M.D.
NEW YORK

Owing to the unsatisfactory diversified use of numerous kinds of skin-grafting devices, it is desirable to cite the Padgett dermatome as an instrument of which the acceptance is a progressive step in skin grafting. In this brief presentation of experience with the dermatome, I do not wish to express any priority or originality; however, it is my ambition to familiarize the members of the ophthalmologic profession with the modern trend in skin grafting about the eye and the orbit. To Dr. Conrad Berens and Dr. Daniel Kirby the New York Eye and Ear Infirmary and the Bellevue Hospital are obliged for the availability of the Padgett dermatome. In his early experience with the dermatome, Berens [1] discovered the convenience of cementing the graft to a form of dental molding compound in the reconstruction of a socket. Hughes [2] promulgated original ideas on utilization of thin dermal grafts fixed to flexible forms and produced colored motion pictures depicting the technic.

Dr. Earl Padgett,[3] of the University of Kansas School of Medicine, in 1938 succeeded in devising a mechanism consisting of a drum and a movable knife at a fixed distance for the excision of a uniform graft of predetermined thickness. By the application of rubber cement to the convexity of the drum and to the donor area of skin, favorable conditions are established for splitting the skin parallel to its fattened surface. By this method a fairly uniform graft which may be from 0.008 inch (0.2 mm.) to full thickness in depth is placed at the command of the surgeon. The area of the graft taken with the dermatome may be as large as 4½ by 8 inches (11 by 20 cm.) or may be any fraction thereof. The instrument not only has regulated the size, shape and depth of skin grafts but has given the surgeon an opportunity to investigate the utilization of grafts from body surfaces not commonly used, e. g. the abdomen and the chest. Grafts from the torso of infants and of patients with severe burns are of particular significance in this

Presented before the New York Academy of Medicine, Section of Ophthalmology, Dec. 15, 1941.

1. Berens, C.: Personal communication to the author.
2. Hughes, W. L.: Personal communication to the author.
3. Padgett, E. C.: Surg., Gynec. & Obst. **69**:779-793 (Dec.) 1939.

regard. When extensive grafting is required the same areas may again be subjected to dermatome section within four weeks.

In grafting to areas where appearance is a prime factor it is essential to have minimal contracture. Under ordinary circumstances a graft about the eye should be from 0.022 inch (0.56 mm.) to 0.028 inch (0.71 mm.) in thickness. The bed on which a graft is placed tends to contract in direct proportion to the thinness of the graft except in the presence of certain anatomic factors leading to formation of a base which prevents contracture. The final external appearance of the grafted area tends away from that of the normal skin proportionately to the thinness of the graft and the condition of the surrounding skin. The percentage of takes with thin grafts is in excess of the expected takes with thick grafts.

The requirements of a graft in plastic surgery of the external lid are such that the Le Fort-Wolfe graft of lid skin from the same or the opposite eye is the most suitable graft available. In consistency of color and in texture this graft is far superior to a graft taken from any other part of the body irrespective of how thin the operator's skill may allow him to split the dermis. The Le Fort-Wolfe graft does not require a mold to maintain its contour, while this factor is of importance in the application of a Thiersch graft. The healed Thiersch graft is usually of a lighter hue than the surrounding skin. In Negroes, a superficial dermal graft may be more deeply pigmented than the adjacent skin. When extensive scarring of the face is present it is sometimes desirable for color matching to choose a Thiersch graft in preference to a graft of darker color. Under average conditions the maximum size of a Le Fort-Wolfe graft available from the skin of the upper lid is 20 to 25 by 50 mm.[4] In cases in which a larger area of skin is required or in which there are defects of both eyes it is necessary to turn to the split dermal graft as a second choice. The area of skin required to reconstruct a socket is approximately 16 sq. cm., or sufficient to cover a form 38 by 24 mm. in size. Owing to the size of the graft and the fact that function is of more importance than appearance, the Thiersch type of graft is universally used. By experience it has been determined that the graft for lining a socket is optimal if its thickness can be regulated to 0.020 inch, or 0.5 mm. At the time of operation it is advantageous to apply a graft of similar thickness to cover the defect produced in exenteration of the orbit. The graft is maintained in contact with the bone by means of a pressure dressing over a flexible form, to which the graft is cemented. The tendency to cut a graft for the orbit too thick is a common mistake of surgeons unfamiliar with grafting in the orbit.

4. Wheeler, J. M.: The Collected Papers of John M. Wheeler, New York, Columbia University Press, 1939, p. 147.

The Padgett dermatome has been of much value in the taking of grafts for the reconstruction of sockets. In the past there has been difficulty in selecting a desirable mold to maintain the proper position of a socket graft. During the past year Hughes [5] has fashioned a flexible rubber form from a section of the ordinary handball. To the surface of this form the thin dermal graft is securely cemented with rubber cement. This procedure provides a smooth external surface for insertion of the form. The flexibility of the rubber form facilitates its removal without canthotomy and with much less distress than was encountered in extraction of the rigid forms previously used.

The advent of rubber cement in plastic surgery has provided a means of fastening a graft to perforated cilkloid [6] to facilitate its handling. A pattern of the area to be grafted may be cut from the cilkloid to determine accurately the size of the graft required to fill the defect. The area surrounding the recipient bed is painted with rubber cement. After the cement on the skin and on the cilkloid backing peripheral to the graft has dried the edges are accurately approximated. This technic insures a smooth flat healing surface, constantly maintains the graft in its proper position and relieves the responsibility of sutures. Excess graft may be replaced on the donor area by the same method.

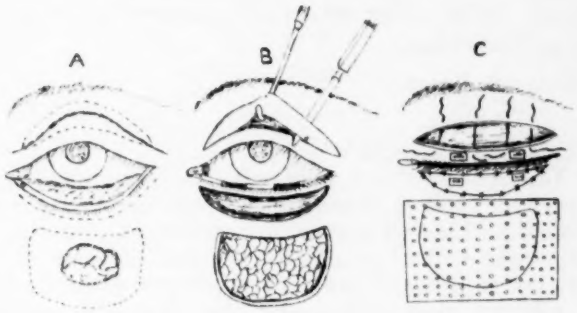
In preparing the skin for the application of rubber cement one must use ether to insure dryness and to remove oil from the surface. It is necessary to dilute the rubber cement with ether to the proper consistency for brushing on in a thin smooth layer. Sufficient time must be allowed for drying before one attempts to cement the drum to the dermis. It is imperative to use a sharp blade. A defective blade will cause irregularity in the thickness of the graft. A New York ophthalmic instrument house efficiently sharpens the blades. One of the dermatomes at the New York Eye and Ear Infirmary developed play between the axle and its housing, which was contributory to undesirable irregularity in the thickness of the grafts. In taking a graft with the dermatome the operator is required to use a simple rolling motion of the drum and avoid pulling or pushing the instrument. It is necessary to execute a rapid sawing motion of the blade mechanism for the best results.

The accompanying diagrams represent a case of carcinoma producing ectropion of the lower lid. The treatment consisted of surgical correction of the ectropion by incision of the skin parallel to the lower lid margin and release of the vertical shortening of the lower lid. Lid adhesions on each side of the pupil were constructed. The carcinoma

5. Hughes, W. L.: Socket Reconstruction: A New Form and Method of Handling the Skin Graft, Arch. Ophth. **26**:965-968 (Dec.) 1941.

6. Perforated cilkloid is a cellulose acetate preparation which may be secured from the Cilkloid Company, of Marshalltown, Iowa.

was then excised, leaving two areas for grafting. The defect in the skin of the lower lid was filled by a Le Fort-Wolfe graft from the upper lid. The denuded area produced by excision of the carcinoma located on the cheek required a somewhat thicker and less pliable graft, because the skin over the cheek is of greater thickness than the skin of the eyelids. The graft to supply skin for the defect in the cheek was taken with the Padgett dermatome set for a depth of 0.030 inch (0.75 mm.). The Le Fort-Wolfe graft was sutured in position with interrupted silk sutures. The dermatome-split skin graft was cemented in position on a backing of perforated cilkloid without the use of sutures. A double layer of perforated cilkloid covered with a thin layer of petrolatum was placed over the entire area to keep the pressure dressing from sticking at the time of its removal. The rubber pegs of the sutures holding the lid adhesions were removed on the fifth postoperative day to prevent



A, in a case of carcinoma of the cheek an ectropion of the left lower lid was incised on the dotted lines. *B*, dissection completed and the bed for the Le Fort-Wolfe and for the split skin graft prepared. *C*, the split skin graft cemented in position, the Le Fort-Wolfe graft sutured, the lid adhesions closed and the donor wound ready for closure.

necrosis of the underlying skin. To insure proper healing the pressure dressing was kept in position for the first fourteen postoperative days.

The difficulties encountered in learning to use the Padgett dermatome are numerous; however, the technic may be mastered with less practice than is required to become adept in the proper use of the skin razor. The initial cost of the dermatome is far in excess of the price of the skin razor. In the hands of a qualified surgeon the small thin grafts used in ophthalmic operations may be easily cut with the skin razor. The latest model of the dermatome is equipped with a single depth-adjusting device based on an eccentric shaft, which is more convenient than the original dual setting arrangement. Ophthalmologists in other parts of the country have requested a smaller model of the machine with a 3 inch (91 cm.) drum. By the inventor I was informed that the

smaller model of the machine does not function as easily owing to the fact that room for the guiding hand is less adequate. Sir Harold Gilles,[7] of London, stated that of the 50,000 injured and wounded war victims in England only 500 have required plastic operations. He found that the dermatome had been accepted and was being used extensively in reconstructive surgical procedures.

SUMMARY AND CONCLUSIONS

The use of lid skin to replace lid skin is preferable to the utilization of thin, split dermal grafts from other parts of the body. When a split skin graft is required it is advantageous and convenient to use a flexible form for handling and maintaining the position of the graft. The convenience of using rubber cement in preference to sutures to maintain the position of a thin graft is described. A case in which two types of grafts were required is presented for a comparative study. A number of precautions to be observed in the successful operation of the dermatome are mentioned.

35 East Seventieth Street.

DISCUSSION

DR. WENDELL L. HUGHES, Hempstead, N. Y.: Since the days of Ollier and Thiersch, who first split skin into layers and used only the superficial ones for grafting, there has been need for a mechanical instrument that could with a fair degree of certainty remove a layer of skin of a certain predetermined thickness. Several instruments previously devised were not at all satisfactory. The Padgett dermatome, while not fool proof, fills the need much better than any other instrument yet devised. In all but the very thinnest of grafts its performance, when it is used with even a moderate degree of skill, produces an extensive layer of dermoepidermis that is excellent. However, in ophthalmic plastic operations it is sometimes desirable to have a very thin layer of epidermis. Even with the blade of the instrument specially sharpened I have been unable to obtain as thin grafts with it as with a specially sharpened skin razor. Dr. Padgett told me that he had had the same experience. However, for most purposes the moderately thin layers obtained with the dermatome are satisfactory. With it a large area of skin without holes may be obtained with greater certainty than with the skin razor.

We found that the blade supplied by the maker was not satisfactory but that when a proper edge was put on it the grafts obtained were satisfactory for most purposes. Some of the instruments have too much play, and transverse ridges are therefore produced in the grafts. It is necessary to master the technic of handling the instrument. The proper amount of rubber cement must be used on the drum and on the skin. The correct pressure and rotation of the drum are necessary in the taking of a proper skin graft.

7. Gilles, H.: Personal communication to the author.

The fact that the layer of skin as taken has on it a layer of rubber cement facilitates handling for many purposes, especially when it can be made adherent to a piece of perforated cilkloid or a form ready for application to the recipient area. Use of a form is particularly valuable in socket reconstruction, as Dr. Smith has pointed out. An article describing the technic was recently published (Hughes, W. L.: Socket Reconstruction: A New Form and Method of Handling the Skin Graft, ARCH. OPHTH. **26:** 965-968 [Dec.] 1941). Reapplication of any excess skin to the donor area is also facilitated by use of cilkloid. The excess may readily be cemented in place by cementing the uncovered areas of the cilkloid to the surrounding skin.

The fact that with a moderate amount of skill a graft that is good enough for most ophthalmic work can be obtained with the Padgett dermatome makes this instrument acceptable, especially to surgeons who do not have the skill necessary in the taking of a graft with the skin razor. With it a larger area of satisfactory cutaneous layer can be obtained than with any other instrument yet devised. This is particularly advantageous when large areas, such as those resulting from extensive burns, are to be covered.

COMBINATION OF CROSS CYLINDER AND ASTIGMATIC CHART IN CORRECTION OF ASTIGMATISM

ALFRED WILSON, M.D.
WASHINGTON, D. C.

Many means are available by which one can arrive at an estimation of the amount of astigmatism present in a given case. Among these are subjective testing with trial lenses, retinoscopy and use of the keratometer, the cross cylinder and the astigmatic chart. In all cases of astigmatism it may be shown that if the eye looks at a number of lines drawn in different directions some lines will be seen more clearly than others. Contrarily, freedom from astigmatism exists when all lines are equal. The possible variations of astigmatism are of course many, owing to the number of degrees of the circle and the possibility of variation in one axis or in many. Even with the most careful examination there may remain some doubt about the correctness of the findings.

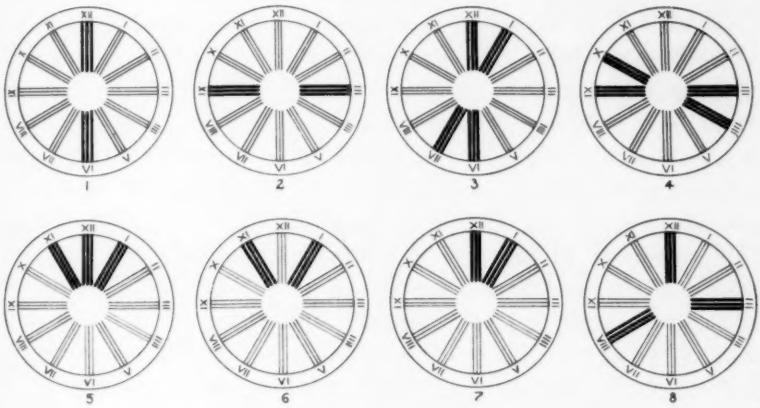
Use of the astigmatic chart has, in my estimation, often been unsatisfactory and the results difficult to interpret. Many times the reason has been that the patient's statements were difficult to interpret in the light of the findings. Any procedure, therefore, that facilitates the examination for physician or patient would appear to be welcome. One suggests the use of cross cylinder and chart.

The patient's difficulty in using the astigmatic chart may arise from, first, poor vision; second, the confusion of irregular astigmatism; third, lack of comprehension of what is required of him, and, fourth, the presence of accommodation which alters the picture frequently and thereby gives a change in the fixation. The operator's difficulties on the other hand, will include those of the patient, which he must understand, and he therefore must consider not using the astigmatic dial, first, when it is inapplicable, for example in the case of irregular astigmatism; second, when the patient's vision is poor, because the use of chart will be less reliable and results less accurate (this is also true of other tests); third, without careful instruction of the patient as a preliminary measure, and fourth, without examination both with and without cycloplegia.

The cross cylinder, in my experience, has been the most important instrument available for the correction of astigmatism, and the astigmatic chart has been at best secondary. However, as a check I believe the chart serves a useful purpose. For a time one practically gave up its

use, because it was so often time consuming and too often an unsatisfactory or obviously wrong answer was given. The patient's answers were inconclusive or did not agree with the other findings. Now I find the chart easier to use and more definitely of value.

In using the combination of cross cylinder and astigmatic chart, I usually use the clock face dial. I prefer to have the patient notice which lines are dark, but the alternative of light lines may be chosen. One may correct by putting minus cylinders over the light lines or plus cylinders over the darker lines till all are equal. It is my custom to add plus lenses to the dark lines. At the same time, I realize that many ophthalmologists prefer to use minus cylinders in their refracting. With vision corrected or normal in all axes all the lines appear to be the same



Clock face dial showing astigmatic lines in black.

shade. With the cross cylinder in place, e. g. plus at 90 and minus at 180, the lines appear dark at 180, or in the same axis as the minus correction. It therefore takes a plus cylinder to equalize the dark lines with the others. Reversal of the cylinder would give dark lines at the 90 degree axis. Use of the cross cylinder over the chart will therefore give lines off shade at the same axis, for example at 180, if the minus cylinder is parallel to 180 degrees. If other lines are dark, for instance at 1 o'clock or 11 o'clock, one must assume that the original correction was wrong or irregular astigmatism is present. If one has used a cylinder to correct astigmatism and the cylinder is turned, one may eliminate the black line at 1 or 11. The cross cylinder may also be used to confirm the axis. If lines are present at only axis 1, 11 and 12, and almost equal, one may assume that the correction is fairly good and some irregular astigmatism is present. Other side effects may be present with irregular astigmatism; for example, a line or lines on only one side of the clock

may be dark or unopposed lines may be dark. Under such circumstances the value of the clock becomes less and the chance of making a good connection depends more on the preference of the cross cylinder and good comfortable vision or, in other words, on the preference of the patient.

The use of the cross cylinder and astigmatic dial combination really requires no special instructions because the use of each is usually already understood. They merely cross check each other and serve, therefore, to prove the true findings.

The combination is, therefore, offered as a simple, accurate and dependable addition to the many means already available for the correcting of astigmatism, its amount and axis. A few diagrams are offered to aid in interpretation of the procedure, which to me has proved so valuable and accurate.

Hollingsworth Clinic.

RIBOFLAVIN

SIGNIFICANCE OF ITS PHOTODYNAMIC ACTION AND IMPORTANCE OF ITS PROPERTIES FOR THE VISUAL ACT

MARCEL HEIMAN, M.D.
MOUNT PLEASANT, IOWA

Since Warburg and Christian described the "yellow enzyme" in the year 1932, a number of papers have been published concerning riboflavin, which is an important part of the yellow enzyme. Chemists and biologists, however, were more successful in isolating riboflavin and in defining its various properties than physicians were in establishing its clinical value. No clinical observations to speak of had been published at the time when I reported on the possibility of a photodynamic action of vitamin B_2, in 1936.[1] Not much attention had been paid to two reports published in the previous years. Von Euler and Adler [2] were the first to report on remarkable amounts of flavin in the retina of certain fishes. In some cases they found as much as 50 mg. per hundred cubic centimeters, the highest concentration to be found in any tissue. The flavin found in the retina is not bound to a colloidal carrier forming the "yellow enzyme" but is free and dialyzable. Since flavin in the dialyzable form is found only in the retina and the liver and since the retina of albinotic animals also contains flavin, the authors suggested that the flavin in the retina may have a special significance in the visual act. They expressed the opinion that riboflavin has a special function during twilight in changing short waves into those of a yellow-green fluorescent light, i. e., into a light of a frequency of waves for which the human eye has the highest sensitivity. In other words, the property of fluorescence may be responsible for dark adaptation. Theorell [3] stated the belief that flavin has something to do with vision generally and with color vision particularly. The fact that free riboflavin under the influence of illumination becomes changed into the so-called primary activated photobody was assumed by Theorell to indicate that this process may be the initiation of the stimulus for the visual impulse. The primary activated photo-

1. Heiman, M.: Ueber die Möglichkeit einer photodynamischen Wirkung des Vitamin B_2, Wien. klin. Wchnschr. **49**:398 (March 27) 1936.

2. von Euler, H., and Adler, E.: Ueber Flavin und einen blau fluorescierenden Stoff in der Netzhaut der Fischaugen, Ztschr. f. physiol. Chem. **228**:1, 1934.

3. Theorell, H.: Quantitative Bestrahlungsversuche an gelbem Ferment, Flavinphosphorsaure und Lactoflavin, Biochem. Ztschr. **279**:186, 1935.

body is very sensitive and disintegrates if sufficient oxygen is not present. The oxygen not only prohibits its destruction but, working in the opposite direction, forms riboflavin again from the primary photobody.

Although the ideas expressed by those authors were sound, they did not find any repercussion in the clinical literature until the year 1939. Spies, Bean and Ashe [4] were the first to relate clinical ocular disease with visual disturbance to a deficiency of riboflavin. They noted a disturbance of vision which disappeared in four to six days after the administration of adequate amounts of riboflavin. Spies, Vilter and Ashe [5] somewhat later in the same year reported that "more than 70 per cent of the patients in the nutrition clinic who have frequent recurrences of pellagra, beriberi or flavin deficiency also have visual disturbances." They observed that "failing vision has responded in some instances to treatment."

A review on a clinical material of about 100 cases published by Pock-Steen [6] in August 1939 was the first report which mentioned specifically the particular type of a visual disturbance observed in his patients. He spoke of a twilight blindness, calling it aknephascopia. It is a reduced visual acuity during weak daylight, such as twilight, and during inadequate artificial illumination. It is different from the night blindness due to lack of vitamin A. This type of visual disturbance is not influenced by the administration of vitamin A but is greatly ameliorated a few hours after the administration of approximately 1 mg. of riboflavin. Sixty-seven of 109 patients noticed a great improvement in their vision after the injection of 1 mg. of riboflavin. The author arrived at the conclusion that "twilight blindness is a symptom of a general B_2 hypovitaminosis and the only one that can be observed clinically."

An equally important contribution was published in 1940 by Sydenstricker, Sebrell, Cleckley and Kruse [7] on a group of 47 persons. It showed the distribution of the ocular symptoms in hospitalized and in nonhospitalized patients and in a group of apparently well persons. All but 2 of the last group complained of "visual disturbances such as photophobia, dimness of vision or 'eyestrain' not relieved by correction of

4. Spies, T. D.; Bean, W. B., and Ashe, W. F.: Recent Advances in the Treatment of Pellagra and Associated Diseases, Ann. Int. Med. **12**:1830 (May) 1939.

5. Spies, T. D.; Vilter, R. W., and Ashe, W. F.: Pellagra, Beriberi and Riboflavin Deficiency in Human Beings, J. A. M. A. **113**:931 (Sept. 2) 1939.

6. Pock-Steen, P. H.: Eye Symptoms in Patients with Leiodystonia and Sprue: Aknephascopia, Geneesk. tijdschr. v. Nederl.-Indië **78**:1986 (Aug. 8) 1939.

7. Sydenstricker, V. P.; Sebrell, W. H.; Cleckley, H. M., and Kruse, H. D.: The Ocular Manifestations of Ariboflavinosis, J. A. M. A. **114**:2437 (June 22) 1940.

refractive errors." Dimness of vision was noted in 14 of 16 hospitalized patients, in 11 out of 13 nonhospitalized patients and in 4 of 18 apparently well persons. The authors found visual fatigue a common symptom in their patients. Regarding the response to administration of riboflavin, they stated that all patients with mild objective impairment of visual acuity were relieved. In 1 of the hospitalized patients the visual acuity improved from 5/200 before to 25/30 after the treatment. With discontinuance of the treatment, the impairment of the visual acuity paralleled the objective signs of relapse in 2 of the patients. The authors pointed to a possible relation of riboflavin to the function of vitamin A, suggested by the similarity of the visual disturbance attributed to the two vitamins. In the summary they wrote: "Photophobia, dimness of vision and actual impairment of visual acuity were promptly, even dramatically, relieved by the administration of riboflavin, in some instances before visible changes occurred in the cornea."

In 1940, too, Sebrell [8] reviewed the literature citing a publication by Sebrell and Butler,[9] who late in 1938 recognized a riboflavin deficiency, without mentioning, however, visual disturbances. Quoting some of the earlier writers, Sebrell found it interesting to recall that Clark in 1909 was the first to mention failing vision besides other ocular symptoms in patients with pellagra. The latest report which is of concern was published by Spies, Bean, Vilter and Huff [10] on endemic riboflavin deficiency in infants and children. Investigating whole families, these authors found in children lesions similar to those in adults. They mentioned failing vision as one of the characteristic ocular symptoms.

To summarize the results of experimental and clinical investigations, it seems that there is evidence of (1) the presence of riboflavin in the retina in large amounts, (2) visual disorders if riboflavin is diminished and (3) reestablishment of the visual function after administration of riboflavin. The visual disorders are described as (1) dimness of vision, (2) impaired visual acuity and (3) photophobia. In the following pages an attempt will be made to determine the role which riboflavin plays in the visual act.

I experimented with riboflavin in order to establish whether it has any photodynamic function, modifying a method which was first used by Lustig and Perutz.[11] The object was to see whether riboflavin has any

8. Sebrell, W. H.: Nutritional Diseases in the United States, J. A. M. A. **115**:851 (Sept. 7) 1940.

9. Sebrell, W. H., and Butler, R. E.: Riboflavin Deficiency in Man: A Preliminary Note, Pub. Health Rep. **53**:2282 (Dec. 30) 1938.

10. Spies, T. D.; Bean, W. B.; Vilter, R. W., and Huff, N. E.: Endemic Riboflavin Deficiency in Infants and Children, Am. J. M. Sc. **200**:697 (Nov.) 1940.

11. Perutz, A., and Lustig, B.: Eine einfache Methode zum Nachweis photodynamischer Substanzen im Harn, Wien. klin. Wchnschr. **46**:1579 (Dec. 29) 1933.

influence on the photochemical action. Strips of printing paper were immersed in a solution of riboflavin [12] for three minutes. In order that the reaction might be compared, only one half of each strip was immersed. This procedure was carried out in the darkroom. The paper strips were dried thoroughly and then exposed to artificial white light for ten to thirty seconds. So far no difference could be seen between the two halves. When a whole strip was developed the following result was to be noticed: The half which had not been in contact with the solution of riboflavin darkened in the usual manner. The immersed half either remained white or became gray much later than the first half, the result depending on the concentration of riboflavin. Interpreting this reaction I assumed (in my report in 1936), I think now incorrectly, that riboflavin may have a photodynamic effect, so far proved only photochemically. It remained to be seen whether (1) well known photodynamic substances would give the same result with the printing paper method and (2) riboflavin would show any photodynamic action with other methods as well as with the biologic test.

Regarding the first question, to test known photodynamic substances with the printing paper method, I used three different materials: (1) acriflavine hydrochloride, (2) a 50 per cent hematoporphyrin hydrochloride solution ("Photodyn") and (3) chemically pure porphyrin. A 2 per cent solution of acriflavine hydrochloride in a dilution of 1 : 100 and the second preparation in the same dilution produced a definite retardation of the darkening of the printing paper. Most instructive, however, was the experiment with porphyrin. Through a colleague I acquired a small amount of chemically pure porphyrin from the laboratory of Prof. Hans Fischer. I worked with 1.6 mg. of coproporphyrin tetramethyl ester. Thus no impurities could be the cause of the reaction. Diluting the substance with hydrochloric acid (concentrated), I obtained a basic solution of which 1 cc. contained 0.1 mg. of coproporphyrin. Diluting that solution 1 : 1,000, I arrived at a solution which was clear macroscopically and contained 0.0001 mg. per cubic centimeter, or 10 micrograms per hundred cubic centimeters, of coproporphyrin. With this solution the printing paper still showed the described reaction. While strong solutions caused a complete inhibition, the printing paper remaining white after being exposed and developed, weaker solutions led to a diminution and retardation of the darkening process corresponding with the concentration. Whatever the explanation for this reaction

12. The first experiments, in 1936, were performed with lactoflavin (Beyer). In the more recent experiments riboflavin was used and was supplied by E. R. Squibb & Sons.

may be, photochemically it was established that riboflavin belongs in the same group as known photodynamic substances.

The tests were performed in the belief that they represented a photochemical equivalent of a biologic photodynamic action. After my experiments Hausmann and Kuen [13] examined riboflavin by means of a photobiologic test. Hausmann had developed a photobiologic method with blood agar plates. Erythrocytes are suspended in a 2 per cent solution of agar, and the questionably photodynamic substance is added to the erythrocyte-agar solution. The solution is then poured on glass plates as a thin film, and after solidification the plates are used like photographic plates. The photodynamic substance sensitizes the erythrocytes to illumination, causing hemolysis. Thus, hemolysis was shown by that method to be a manifestation of the photodynamic action of a substance. Hausmann and Kuen, now, could show that riboflavin has a hemolytic effect in the ultraviolet portion (the part of the longer waves, especially) and in the visible portion of the spectrum to a wavelength of 435 millimicrons. Its photodynamic effect extends from 280 to 435 millimicrons. (It ought to be mentioned, however, that the authors did not submit riboflavin to exposure of light beyond a wavelength of 577 millimicrons.) Thus was the photodynamic effect of riboflavin proved by a reliable method, although only photobiologically. Heiman and Brandt [14] finally demonstrated the photodynamic action of riboflavin by a biologic test. Five to thirty minutes after the subcutaneous injection of 1 cc. of riboflavin, patients were treated with ultraviolet radiation and with sunlight. The erythema dose for each patient had been determined previously. Usually fifteen minutes after the injection of riboflavin the effect of irradiation was markedly increased as compared with the effect without riboflavin.

Although reexamination of those findings would be desirable, they seem to indicate that, as demonstrated by the photobiologic and the biologic test, riboflavin has a photodynamic action. Riboflavin, as a photodynamic substance, on the other hand, gave the same result as porphyrin with the photochemical method. Do these results justify the conclusion that the printing paper method is a test for the photodynamic action? Or is it not possible that riboflavin has a property which, separately from the photodynamic action, leads to the described result of interfering with the chemical process of photography? These considerations, although theoretic, are of interest because it was thought that an analysis of the photochemical process could give information regarding the function of riboflavin during the visual act.

---

13. Hausmann, W., and Kuen, F. M.: Ueber photobiologische Sensibilisation und Desensibilisation im Ultraviolett, Strahlentherapie **60**:270, 1937.

14. Heiman, S., and Brandt, R.: Personal communication to the author.

Photography is based on the production of the "latent image" [15] by exposure. The development is the manifest separation between exposed and unexposed silver halide. The contact of riboflavin with the photosensitive substance—the silver halide—before exposure inhibits during the photographic development the manifest separation. Does riboflavin inhibit the formation of the "latent image?" This question was solved as follows: If printing paper is first exposed and then contacted with riboflavin, the developer blackens the paper, this fact indicating that riboflavin is not effective after the latent image is formed. If printing paper after being contacted with riboflavin is washed in a water bath for one hour and then exposed, the developer darkens the paper. This indicates that washing abolishes the effect of riboflavin and reestablishes the printing paper. In the interpretation of these tests it was thought that riboflavin prohibits the formation of the latent image. Generally speaking, riboflavin protects the photosensitive substance against the light.[16]

Admitting here that my first assumption was wrong, namely that the printing paper method proves the photodynamic action of riboflavin, I believe that the method, nevertheless, appears to have been helpful in establishing two facts: 1. Investigations after my first report did show riboflavin to have a photodynamic effect. 2. Reexamination of various photodynamic substances with the printing paper method yielded a uniform result, indicating that riboflavin has a protecting effect on the photosensitive substance.

COMMENT

What evidence is there for the assumption that riboflavin is related to the visual act? First, the clinical observations which have been referred to in detail. Second, the fact that riboflavin is present in the retina. Third, certain properties to be discussed, which seem to be of importance for a substance engaged in the visual process. Fourth, similarities between riboflavin and carotene, a substance of established importance for the visual act. Fifth, the postulation of another visual substance in the retina besides the visual purple.

---

15. "The exposed silver halide is known as the 'latent image.' The fundamental property of the 'latent image' is that of facilitating the deposition of silver in a reducing agent, such as the developer." (Photography, in Encyclopedia Britannica, ed. 14, New York, Encyclopedia Britannica, Inc., 1929.)

16. C. E. K. Mees, of the Eastman Kodak Laboratories, Rochester, N. Y., supplied me with valuable information and read through the manuscript of this paper. He informed me that there are several substances known which act like riboflavin in respect to printing paper. Such substances are called "desensitizing substances." "They are primarily those which are oxidizers or which catalyze oxidation and prevent light from having its normal reducing effect." (It is well known that riboflavin has such a property.)

First: Analysis of the clinical findings discloses that three distinct visual disorders have been observed: dimness of vision, impairment of visual acuity and photophobia. Pock-Steen observed dimness of vision and recognized it as due to riboflavin deficiency manifested during weak daylight and inadequate artificial light. Sydenstricker and associates noted in their cases a reduction of the visual acuity which responded well to administration of riboflavin. Several authors observed photophobia as another subjective symptom. In most cases the photophobia was probably the result of pathologic changes in the cornea and in the conjunctiva. In some cases fixed mydriatic pupils may have been responsible for it. In several cases, however, there seem to have been complaints about photophobia when no other symptoms but impaired vision were present. In those cases the photophobia was seemingly not connected with objective changes in the eye. It will be seen later how photophobia could be explained as a symptom of riboflavin deficiency.

Second: It becomes ever more apparent that the presence of riboflavin in the retina is in some way related to the visual act. The presence of riboflavin in the retina in amounts greatly exceeding those found in any other tissue of the body indicates the importance of its function. Riboflavin as part of the "yellow enzyme" is necessary for the respiration of the cell. In the retina it cannot have the same function, since it is not connected with a colloidal carrier. Von Euler and Adler [17] tried to determine the exact place where riboflavin is found in the retina. They found it only in the layer of pigmented epithelium (the posterior layer of the optic vesicle). The layer anterior to it, the layer of rods and cones, does not contain any riboflavin. It seems to be important that these authors never found riboflavin together with the visual purple. "Riboflavin is not present in that part of the stratum pigmenti which contains the visual purple but only in that part which contains melanin." The authors did not examine the various structurally different parts of the retina; at least they did not mention doing so. Thus it is not known whether the part of the retina which is devoid of visual purple, the fovea centralis, contains riboflavin solely ("yellow spot"). The establishment of this fact would be an important link.

Third and fourth: One of riboflavin's characteristic properties is its yellow-green fluorescence. Booher [18] in a recent survey stated that the retinas of animals contain riboflavin in a concentration corresponding to that at which the maximum of fluorescence occurs. The relation of the fluorescence to vision in a dim light as suggested by Von Euler and

17. Von Euler, H., and Adler, E.: Ueber das Vorkommen von Flavinen in tierischen Geweben, Ztschr. f. physiol. Chem. **223**:108, 1934.

18. Booher, L. E.: Chemical Aspects of Riboflavin, J. A. M. A. **110**:1105 (April 2) 1938.

Adler seems to be accepted by most authors (Hogan[19]). In dim light riboflavin makes it possible to use shorter waves by changing them into yellow-green fluorescent light, which has a length of waves for which the human eye has the maximum sensitivity. The transformation of riboflavin in a neutral or acid solution into lumichrome under the influence of illumination was mentioned as the basis for Theorell's conception. Riboflavin in an alkaline environment, on the other hand, would be converted into the less active lumiflavin. This is well in accordance with the fact that the retina becomes acid in reaction on exposure to light. The conception of Theorell is similar to that of Hecht.[20] Both authors believe that the light does not act on the rods and the cones themselves but on an intermediate substance which is interpolated between the photosensitive substance—the rods and the cones—and the light. The function of the rods and the cones depends on the intactness of the interpolated substance. What property may be expected from a substance like that? In the first place, one may expect that the transformation due to illumination will be fast and reversible. This seems to be the case with riboflavin in the retina provided that sufficient oxygen is present. The reversibility from the "primary activated photobody" back into riboflavin depends on the presence of oxygen. A dearth of oxygen, on the other hand, is detrimental to riboflavin, leading to formation of deuteroriboflavin, which apparently has none of the properties necessary for the visual function.

It seems, however, that the relationship between the photosensitive and the interpolating substance has not yet been described completely. Not only does the intermediate substance contribute the impulse by its chemical change, but this visual substance may have two other functions. At least, the previously mentioned investigations have suggested such functions, namely those of intensification and of protection. First I shall consider the photodynamic property. That a photodynamic action is found in a substance engaged in a process of a photochemical nature should not be surprising. Chlorophyll for a long time has been known to possess a photodynamic property. Carotene, the effective agent of the visual purple, has been examined with respect to such a property by Kuen and Pueringer.[21] They found that it showed a photodynamic

19. Hogan, A. G.: Riboflavin: Physiology and Pathology, J. A. M. A. **110:** 1189 (April 9) 1938.

20. Hecht, S., cited by Wiggers, C. J.: Physiology in Health and Disease, Philadelphia, Lea & Febiger, 1934.

21. Kuen, F. M., and Pueringer, K.: Ueber die sensibilisierende Wirkung der Blattfarbstoffe Chlorophyll, Carotin und Xanthophyll, Biochem. Ztschr. **286:**196, 1936. Stepp, W.; Kuehnau, J., and Schroeder, H.: Die Vitamine und ihre Anwendung, Stuttgart, Ferdinand Enke, 1938.

action, strongest at wavelengths between 280 and 435 millimicrons. Recalling here that riboflavin exhibits its photodynamic activity within exactly the same range of waves, one sees a congruity of the two substances found in the retina that can hardly be coincidental considering other properties which carotene and riboflavin have in common. For instance, carotene, like riboflavin, is to be found in the retina in far higher concentration than in any other tissue with the exception of the liver. A common function is that of fluorescence, the importance of which for the visual act I discussed with regard to riboflavin. Since both substances, carotene and riboflavin, manifest their photodynamic properties toward the same part of the spectrum (a deficiency of either one, on the other hand, was found to be responsible for diminished vision during twilight) it may be assumed that the photodynamic action takes place during that particular light condition. Thus I believe that fluorescence and photodynamic action together are important functions, guaranteeing the proper function of the eye at reduced light.

Insufficient stimulation, although not dangerous, is as impedimental to the normal visual function as is too strong stimulation, too bright light. With such stimulation it would be beneficial to have a substance which could protect the photosensitive cells. I should like here to be permitted to associate the effect of riboflavin on printing paper with the function of riboflavin in the retina. I want to state that this consideration is purely theoretic and needs further experimental investigation. I believe that riboflavin—as well as carotene—represents a buffer substance. While its photodynamic action supports the visual function during weak light, riboflavin forms a protection against strong light. The excess of light is screened off by the action of riboflavin, injury to the photosensitive cells thus being avoided. A dearth of riboflavin becomes noticeable clinically as photophobia, owing to the influence of light on the unprotected photosensitive substance.

Fifth: The various clinical symptoms of ariboflavinosis are associated with different manifestations of the function of riboflavin. The dimness of vision corresponds to the photodynamic action and the fluorescence, being caused by their reduction. The photophobia is the correlated clinical symptom of the protective property of riboflavin, manifested by its absence. It seems that riboflavin and carotene share equally in these functions. It has been noted that Sydenstricker and co-workers observed a marked reduction of the visual acuity in some of their patients, with decided improvement following riboflavin therapy. The visual acuity is a function limited to the fovea centralis. The fovea is characterized by two factors, absence of rods and—since the presence of rods is related to the presence of visual purple—absence of visual purple. The presence of another visual substance has always been postulated. The point of

sharpest vision devoid of a visual substance could not have been understood otherwise. I believe that clinical observation points to riboflavin as that second visual substance, exercising its function at the point of sharpest vision. If this theory was verified, riboflavin would excel carotene in importance in the visual act. Riboflavin, then, would be the only substance connected with the function of focusing, fixating and forming the sharpest possible image.

The photosensitive substance is divided into two functionally different parts, the rods and the cones. Accordingly, one finds a duality of the visual substance: carotene and riboflavin. While it has been proved that rods and carotene form a functional unit, proof is still missing regarding the other unit, cones and riboflavin. It is, however, postulated here that such a unit exists.

SUMMARY

To summarize the clinical and experimental facts, I believe that riboflavin is:

1. Conveyor of the physiologic stimulus, as suggested by Theorell. This function is based on the ability of riboflavin to form an oxidation reduction system. Riboflavin is the only conveyor substance in the fovea centralis.

2. Transformer of short light waves into those of maximum intensity, as suggested by Von Euler and Adler. This function is based on the property of fluorescence.

3. Intensifier of weak and insufficient light, as indicated by its photodynamic action. This function seems to have its maximum effect for the short waves of the spectrum.

4. Protector (of the cones?) against the effect of excessive light, as suggested by a similar effect demonstrated in the photochemical method.

The clinical symptoms of ariboflavinosis are explained as manifestations of inactivity of the different functions of riboflavin. Diminished visual acuity is due to a lack of riboflavin in the fovea centralis and its effect on the conveyor function. Dimness of vision is based on the lowered function of transformation and intensification. Photophobia is the manifestation of the reduction of the protective function.

It is believed that the various functions of riboflavin affect the visual act only as far as the cones are concerned. Riboflavin and the cones form a functional unit.

Various similar characteristics of riboflavin and of carotene suggest that the two substances are engaged in the same functional processes of vision. Thus continuation of vision is guaranteed even after complete loss of either substance.

Mount Pleasant State Hospital.

HYALINE SCLERAL PLAQUES

P. H. BOSHOFF, M.D.
JOHANNESBURG, UNION OF SOUTH AFRICA

The presence of hyaline patches in the anterior half of the sclera has only recently received the attention of a few ophthalmologists. The condition is by no means rare, and it is rather surprising that so few contributions to the subject have been made. Although clinically obvious, these hyaline areas usually escape notice because the patient rarely draws attention to their presence. If more workers record their observations on this degenerative condition, then its more obscure aspects will become known. In this paper I wish to describe my findings in 11 cases which I have personally observed and also to discuss the available literature.

As far as I am aware, Pillat [1] in 1933 gave the first full description of this condition. He outlined its essential features: (*a*) the relation of the plaques to the insertions of muscles and (*b*) the occurrence of these plaques in senile subjects. He mentioned a case in which plaques were situated at the insertions of the internal, lateral and inferior rectus muscles. Soon afterward, in 1936, Graves [2] mentioned the presence of superficial "holes" or "excavations" on the sclera. In the following year he published a more detailed description.[3] At the time he was not aware of Pillat's work.[4] In later articles [5] Graves explained why in his first report he regarded this condition as a congenital defect. Gasteiger [6] in 1937 also described the condition as a senile degeneration at the insertions of the ocular muscles. Culler [7] was the first author to describe

1. Pillat, A.: Peculiar Senile Degeneration at Point of Attachment of Rectus Muscles, Ztschr. f. Augenh. **82**:113, 1933.

2. Graves, B., in Berens, C.: The Eye and Its Diseases, Philadelphia, W. B. Saunders Company, 1936, p. 468.

3. Graves, B.: Bilateral Mesial Superficial Deficiency of the Sclera, Brit. J. Ophth. **21**:534, 1937.

4. At about the same time as Pillat, K. Ascher (at an ophthalmologic congress in Vienna) also described this condition. I regret having lost trace of the reference. The question of priority has therefore not yet been settled.

5. Graves, B.: (*a*) Bilateral Mesial Superficial Deficiency of the Sclera: Scleral Plaques, Brit. J. Ophth. **23**:191, 1939; (*b*) Bilateral (Mesial) Deficiency of the Sclera: Scleral Plaques, ibid. **25**:35, 1941.

6. Gasteiger, H.: Senile Degeneration at Point of Insertion of Ocular Muscles, Klin. Monatsbl. f. Augenh. **98**:767, 1937.

7. Culler, A. M.: The Pathology of Scleral Plaques, Brit. J. Ophth. **23**:44, 1939.

the microscopic appearance of the lesions. He established the fact that they are circumscribed plaques of hyaline degeneration. Kyrieleis [8] in 1939 discussed the condition as circumscribed scleromalacic patches, although he recognized the fact that they are of senile degenerative origin.

A general description of these plaques as observed by myself and previous authors is as follows: Hyaline plaques occur in the anterior scleral calotte in elderly patients. They are situated about 3 mm. from the limbus and 2 mm. anterior to the muscular insertions, to which they bear a definite relation. A plaque if elongated lies parallel to the line of muscular insertion and if in the shape of a small rounded patch is usually situated near either end of the insertion of a rectus muscle. It seems possible that the degeneration may appear opposite the insertion of any rectus muscle, although the frequency of occurrence at any particular site varies; i. e., the plaques are most common opposite the medial rectus and less common opposite the lateral rectus and rarely occur opposite the inferior rectus muscle. No case of scleral hyalinization opposite the superior rectus muscle has as yet been described, although such hyalinization may possibly occur. The plaque if fully developed is usually 2 mm. broad and 6 mm. long,[7] and the depth of penetration into the sclera by the hyaline mass is variable. In some cases only one eighth of the normal scleral tissue remains in the deeper parts. The size may vary from that of a pinhead, in which case the plaque is usually rounded, to that of the previously described large plaque, which is oblong. Medial and inferior plaques are usually bilateral. The majority of lateral plaques show no tendency to be bilateral. Owing to the background of dark uvea, these plaques appear clinically as slate gray patches. There is no disturbance of the overlying conjunctiva. A pinguecula may hide a plaque from view, but when the conjunctiva is moved to one side the patch becomes visible. On transillumination through the pupil, the hyaline area shows up as a relatively clear translucent window. Episcleral and conjunctival blood vessels course normally over the patch, except, perhaps, for some tortuosity consistent with the vasosclerotic state of the patient. The patches are not depressed or elevated and are essentially a part of the sclera. It is important to stress that the edges are clearcut and bordered by a 0.25 to 0.5 mm. yellowish line of changed scleral tissue, which merges into the rest of the scleral tissue. This demarcation line is formed by the swollen ends of scleral fibers, which end abruptly against

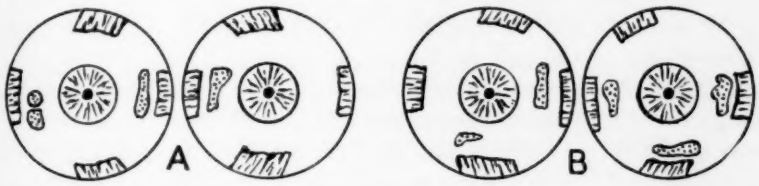
8. Kyrieleis, W.: Circumscribed Scleromalacia in Advanced Age, Klin. Monatsbl. f. Augenh. **103**:441, 1939. Usher, C. H.: Pathology of the Coloured Areas in the Sclerotic, Brit. J. Ophth. **16**:671, 1932.

the hyaline area.[7] The plaques occur in elderly patients. My youngest patient was 57. He suffered from severe gouty arthritis of the feet and hands. Scleral plaques occur to the same extent in the two sexes.

In discussion, I should like to touch on a few aspects of this interesting scleral change. As far as I know, the change is not dangerous to the eye except for the fact that a contusion is liable to produce a scleral rupture. Future reports and observations may establish this fact.

A sclera may become thinned out in the anterior ocular segment [8] and the uveal background may produce a diffuse dark discoloration, but this change is distinct from circumscribed senile hyaline plaques. Scleromalacia [9] appears to be an entity distinct from scleral hyaline plaques. Scleromalacia is not confined to elderly persons. It is usually situated under the upper eyelid, and its commencement and course differ in every respect from scleral hyalinization. The connection between these two conditions, if any, is at the moment unknown.

There seems to be a definite connection between polyarthritic diseases (rheumatic, rheumatoid and gouty) and scleral hyaline plaques. Many



A, elongated mesial and rounded lateral plaques of a man aged 57. *B*, bilateral mesial plaques, bilateral inferior plaques and a lateral plaque in the left eye of a woman aged 65.

patients have no serious arthritic involvement, for example Culler's [7] patients. Of my series of 11 patients, 4 had arthritic changes in the knees, feet and hands. Of these 4, 2 had severe arthritic changes of the gouty type and also had severe ocular changes. One patient was a man of 57 with well defined elongated mesial plaques and with two round lateral plaques in the right eye (*A* in the accompanying illustration). The other patient was a woman of 65 who had bilateral mesial plaques, bilateral elongated inferior plaques (the smaller one being in the right eye) and an elongated lateral plaque in the left eye (*B*). The fact that one of these patients was only 57 and that both had such marked ocular changes leads one to a tentative conclusion that an arthritic diathesis plays a role in the production of the plaques. One also suspects that gout produces the changes more readily than the other forms of polyarthritis. Of the remaining 7 of my patients, all had bilateral mesial

9. van der Hoeve, J.: Scleromalacia Perforans, Arch. Ophth. **11**:111 (Jan.) 1934.

plaques, 1 had bilateral lateral plaques and 1 had a lateral plaque in the right eye. Only 1 of these patients was entirely free of objective signs of arthritic involvement, but he had vasosclerotic changes to a severe degree. Among my patients I have not discovered any other constitutional dyscrasia which may have anything to do with scleral plaques.

These plaques appear in an area of the sclera where the blood supply is poor. It is probable that hyalinization is directly due to a local deficiency of blood supply, resulting in a degeneration of scleral fibers of the hyaline type. There are indications that the changes are produced mainly by two factors which affect the intrascleral blood supply: (1) capillary obliteration in an arthritic diathesis and (2) obliteration of blood vessels due to sclerotic changes. The essential factor in all cases may be vasosclerosis, which may be aggravated or appear earlier when the patient suffers from gout or rheumatism. This part of the sclera is more liable to hyaline changes not only because of its poor circulation of blood but because of the stress and strain on the scleral fibers in the proximity of the insertions of the rectus muscles. It is interesting to observe that the mesial plaques occur most often. Is their greater frequency due to the pull by the strong internal rectus muscles in the often executed movement of convergence? The medial rectus muscles (compared with the lateral rectus muscles), in addition to taking part in ocular conjugate movements have the function of convergent movements, and this may explain why the mesial portion of the sclera is more exposed to the influence of stress and strain than the lateral portion.

A small plaque seems to enlarge by contiguous spread in a direction parallel to an insertion of a rectus muscle. Different shapes of plaques in all stages of development will have to be seen before one can decide exactly how separate round patches actually become confluent and how fast these areas enlarge.

I support Culler [7] and Graves [5b] in their choice of a name, because the name "scleral plaques" or "scleral hyaline plaques" exactly describes the essential nature of the condition.

SUMMARY

Scleral hyaline plaques are not so rare as would appear from the literature. The condition is a distinct entity, and it may be related to polyarthritic conditions and vasosclerosis. The plaques are always situated anterior to the insertions of the rectus muscles. In addition to mesial and lateral plaques, a case of inferior plaques is described. Some problems connected with this senile change are touched on and possible lines of research indicated.

Lister Building.

VALUE OF ORTHOPTIC FUSION TRAINING EXERCISES IN STRABISMUS AND RELATED CONDITIONS

MARY JANE FOWLER, M.D.
CHICAGO

The long-debated question of the value of orthoptic training exercises in strabismus and allied conditions is still unanswered. The orthoptic clinic of the Albert Merritt Billings Hospital ophthalmic clinic therefore presents a summary of an extended study of 192 cases, carried out over a period of twenty months, May 1938 to January 1940. The survey includes cases of the following types of conditions:

I. Strabismus		
A. Accommodative convergent strabismus (eyes straight with glasses on)		45
B. Nonaccommodative convergent strabismus (squint present despite use of glasses)		
1. Convergent strabismus, patient not operated on		
(*a*) Operation not necessary (angle of squint 10 degrees or less)	30	
(*b*) Operation still necessary	30	
	60	
2. Convergent strabismus, patient operated on	56	
		116
C. Divergent strabismus		21
II. Allied conditions		
A. Anisometropia alone		5
B. Poor vision in one eye or poor reading ability		5
Total		192

PROCEDURES USED

Examination of the visual acuity was made with the Snellen letter or illiterate E charts. When the patient was less than 3 years old his central fixation was tested by determining his ability to look at a pocket flashlight. The child's ability to place his forefinger on the flashlight bulb was another indication of his visual acuity. Any 1 year old child will learn easily to perform this act. All amblyopic eyes were found to have variable and uncertain fixation; the children were unable to touch the flashlight easily and readily and even objected to the momentary occlusion of the better eye. All angles of convergence were measured on the perimeter with fixation at 14 inches (35 cm.) and also at 20 feet (6 meters) both with the vision unaided and with the glasses on. Every patient received a refrac-

From the Division of Ophthalmology of the University of Chicago, the School of Medicine, E. V. L. Brown, Director.

tion test under atropine cycloplegia (1 per cent atropine sulfate solution four times a day in each eye for three days, with refraction on the morning of the fourth day). All patients were treated with the full atropine correction in the glasses, with the one exception of those who had divergent squint and were hyperopic. Such patients received no glasses or only the cylindric correction if this was high. Travers [1] advocated full atropine correction of hyperopic astigmatism and myopia, undercorrection of hyperopic astigmatism and myopia and undercorrection of hyperopic divergent squint.

After one month of constant use of the glasses, the patients were examined on the synoptoscope for fusion. The only exceptions were the patients with too great a convergence angle (more than 60 prism diopters of convergence) and those under 2 years of age. Simultaneous macular perception was tested by the targets "F" for the right eye, and "L" for the left eye on the Keystone View letter chart. These letters measure 2 mm. in height. The amplitude of fusion was measured by the larger set of targets used to test type II fusion. These measure 25 mm. horizontally and 42 mm. vertically. If abnormal retinal correspondence [2] (anomalous projection, Verhoeff [3]) was present an attempt to produce fusion was made in every case, through about fifteen to thirty minutes of each visit, every four to six weeks. Retinal "massage" [4] at the objective angle was executed, as Pugh [5] advocated. The results were most disappointing, because in none of 86 cases of abnormal retinal correspondence did fusion develop. Total occlusion of the better eye or alternating occlusion of one eye for one week was continued all the time the patient was not in the clinic for exercises. Wurdemann,[6] Cantonnet and Filliozat have contended that 70 per cent of patients with squint can be cured by orthoptics. However, not one of the 182 patients with squint (including both those with normal and those with abnormal retinal correspondence) was cured by orthoptic training alone. Smith's [7] definition of abnormal retinal correspondence was accepted, i. e., the condition in which the difference between the subjective and the objective angle is greater than 5 prism diopters. In 33 of the 86 cases of abnormal retinal correspondence the angle was found to be greater; i. e., the subjective angle was about 10 prism diopters less convergent than the objective angle. All exercises were individual; i. e., all were carried out by me personally on the synoptoscope. I agree

1. Travers, T. àB.: Comparison Between Visual Results Obtained by Various Methods Employed for the Treatment of Concomitant Strabismus, London, George Pulman & Sons, Ltd., 1936.

2. Abnormal retinal correspondence exists when the objective angle is not equal to the subjective angle and the difference between the two is at least 5 prism diopters (Smith [7]).

3. Verhoeff, F. H.: Anomalous Projection and Other Visual Phenomena Associated with Strabismus, Arch. Ophth. **19**:663 (May) 1938.

4. "Retinal massage" is a method of reeducation of the macula of the retina in each eye at the objective angle of squint on the synoptophore. One or both maculas receive images moving rapdily within a range of about 5 prism diopters produced by the slight but rapid shaking of one or both targets at the objective angle by the technician.

5. Pugh, M. A.: Squint Training, London, Oxford University Press, 1936.

6. Wurdemann, H. V.: Orthoptic Treatment, Eye, Ear, Nose and Throat Monthly **14**:261, 1935.

7. Smith, M. T.: Significance of False Projection in Treatment of Squint, Arch. Ophth. **21**:990 (June) 1939.

with Bressler,[8] Peter[9] and Wells[10] that the major amblyoscope[11] (orthoptoscope, synoptoscope, synoptophore) is the most useful instrument for fusion training and that the stereoscope has but a limited value in orthoptics. The standard used for stereopsis was the Keystone View Betts stereopsis card DB6. This is equivalent to the Harvey Dolman test. On this card, the degree of stereopsis is designated according to the number of lines in which the patient can detect stereopsis. The patients having "100 per cent" stereopsis (those with orthophoria and some of those with divergent strabismus or convergence insufficiency) were able to detect correctly stereopsis in all ten of the lines on the card. Patients with accommodative convergent strabismus and anisometropia had "20 to 70 per cent" stereopsis, whereas some of those lacking fusion, i. e. those with abnormal retinal correspondence, could recognize the stereopsis of the "10 per cent" line, owing to monocular parallax.

Treatment by total occlusion was instituted after the patient had worn the glasses for one month. The visual acuity of each eye was checked every four to six weeks throughout the period of occlusion. In only 1 case did the visual acuity of the better eye decrease any appreciable amount (20 per cent) under the occluder. Occlusion was done by the use of the "oculidor," a black celluloid cup-shaped shield fitting onto the inner side of the lens of the glasses by a suction cup.[12] "Glassine,"[13] a clouded white paper mending tape applied to the lens of the glasses when moistened, was substituted for the oculidor whenever the visual acuity of the weaker eye became 0.2 Snellen or better.[14] Three children of school age could not tolerate total occlusion. The period of occlusion was then limited to several hours a day at near work.[15] Children 5 years of age or younger (as young as 8 months) accepted satisfactorily the total occlusion therapy.[16]

No surgical therapy was considered until the patient was 4 years old and had worn full atropine correction in the glasses for at least six months and six months of total occlusion had been carried out in an attempt to improve the vision of the weaker eye.

---

8. Bressler, J. L.: Orthoptic Treatment of Strabismus, Illinois M. J. **68**:273, 1935.

9. Peter, L. C.: Extra-Ocular Muscles, Philadelphia, Lea & Febiger, 1927.

10. Wells, D. W.: The Stereoscope in Ophthalmology, Boston, Mahady & Co., 1926.

11. MacAlpine, P. T.: Collective Review of Orthoptic Treatment of Strabismus 1935-1939, Internat. Abstr. Surg. **71**:1, 1940; in Surg., Gynec. & Obst., July 1940.

12. Occlusion therapy was suggested by Buffon as early as 1743 according to L. L. Mayer (Modern Developments in Orthoptic Training, Arch. Ophth. **8**:888 [Dec.] 1932).

13. "Cadillac transparent gummed glassine" is manufactured and sold by the S. S. Kresge Co.

14. Keith, Lyle and Sylvia Jackson (Practical Orthoptics in the Treatment of Squint, London, H. K. Lewis & Co., Ltd., 1937), Pugh[5] and Travers[1] advised complete continuous occlusion in all cases of amblyopia.

15. Sanford Gifford also met with failure in the attempt to use occlusion in cases of amblyopia when the vision was less than 20/200 (Treatment of Strabismus, Brit. J. Ophth. **19**:148, 1935).

16. Charles Goulden (Strabismus, Tr. Ophth. Soc. U. Kingdom **55**:576, 1935) and Worth stated the belief that poor results would be obtained if the child was over 6 years of age. Sheila Mayou stated she had found the "optimum age" to be 5 or 6 years (Principles of Orthoptic Training, Brit. J. Ophth. **20**:360, 1936).

REPORT OF CASE STUDIES

I. STRABISMUS

A. *Accommodative Convergent Strabismus (Forty-Five Patients).*—When first examined on the synoptoscope 37, or 90 per cent, of 41 patients (all wearing full correction for the refractive error) were found to have normal retinal correspondence, i. e. the faculty of fusion. The range of fusion was low in all patients, averaging 21 prism diopters, in comparison with a low normal of about 40 prism diopters.

Three of the remaining 4 patients had abnormal retinal correspondence as tested on the synoptoscope, with the objective angle at 13 prism diopters of convergence and the subjective angle at 3 prism diopters of convergence. The fourth patient had an objective angle at 10 prism diopters of convergence but subjective suppression of the image of the convergent eye throughout the range between 10 prism diopters of divergence and 5 prism diopters of convergence.

Twenty-four of the 37 patients with fusion showed an average of 40 per cent stereopsis with Betts test card DB6 on the Keystone apparatus.

Thirty per cent of the 45 required occlusion of the better eye. Routine examination and determination of the visual acuity were made every six weeks during occlusion treatment. The average period of occlusion was five months, but 4 patients had occlusion for nine to twelve months. Sixty-one per cent (8 of 13 patients) obtained an average increase of 0.2 Snellen (or 20 per cent) in the vision of the poor eye, and all 8 were able to read newspaper print (8 point Snellen type) at 6 to 11 inches (15 to 28 cm.). Two other patients showed no improvement after one and five months of occlusion. On the other hand, 2 who were too young for an accurate test of visual acuity lost all manifest squint after one and three months of occlusion; i. e., the eyes were straight with the glasses on. Two ideally cooperative children, aged 4 and 7 years, respectively, went through concentrated orthoptic training, namely a series of ten thorough exercises of thirty minutes each in the clinic, but no improvement of the low range of fusion resulted in either.

Forty-four per cent of the 45 patients had no manifest squint for distance or for near objects without the glasses after three years of treatment. The average age of this outgrowth of the squint was 6½ to 8 years.

One child, J. P., aged 9 years, wore an oculidor on the right eye for six weeks in an attempt to improve vision in the left eye of 0.3 Snellen. No improvement occurred in the distance vision, but the left eye was able to read 8 point Snellen type (newspaper print) at 11 inches.

Two other patients had concentrated orthoptic exercises, consisting of ten exercises in the clinic, each a half-hour in duration, within a three week period:

J. M., 4 years old, had a synoptoscopic fusion range of 15 prism diopters extending from zero to 15 prism diopters of convergence. After ten supervised exercises on the amblyoscope and stereoscope (Dvorine cards) he did not show any change in the range of fusion. He had 60 per cent stereopsis, and this did not improve with the exercises.

M. S., 7 years old, had a fusion range from 5 prism diopters of convergence to 23 prism diopters of convergence. After ten concentrated exercises on the synoptoscope the range of fusion showed slight change; i. e. it extended from 2 prism diopters of convergence to 28 prism diopters of convergence. The stereopsis improved from 60 per cent to 70 per cent. No further change occurred after a series of conscientious fusion exercises on the stereoscope at home for four weeks.

Comment: This study of patients with accommodative convergent squint leads to certain conclusions: first, that use of glasses and occlusion constitute highly satisfactory treatment—the manifest squint was relieved in 44 per cent of the 45 cases; second, that an adequate fusion faculty is absent in all cases, and, third, that the existing weak fusion faculty cannot be improved by synoptophore exercises.

B. *Nonaccommodative Convergent Strabismus (One Hundred and Sixteen Patients).*—Of the 161 patients with convergent strabismus, 116 were not relieved by the use of glasses (full atropine correction), and their condition was therefore classified as nonaccommodative. Of these 116 patients, 86 were found to need surgical correction. The remaining 30 did not require surgical correction, for they had a residual convergent squint of only 5 to 10 degrees with the glasses on. Fifty-six of the 86 have been operated on, and 30 still await operation.

Patients Not Operated on: In the group awaiting operation the average angle of convergent squint was found to be 26.6 degrees for near objects; with the glasses on this was reduced to 20 degrees. Eleven patients had right, 10 had left and 9 had alternating convergent squint. The age of onset averaged approximately 1 year and 7 months and varied from newborn to 4 years. Only 3 patients had a history of previous acute disease, i. e. pneumonia, whooping cough and rickets. All the 30 patients had hyperopic astigmatism. Fusion tests on the synoptoscope revealed abnormal retinal correspondence in 17 of the 18 patients examined, in comparison with the 4 of the 41 patients tested in the group with accommodative squint. The average objective angle was 40 prism diopters of convergence, and the subjective angle was approximately 13 prism diopters less convergent than the objective angle. Only 1 patient had fusion, and his range was low (13 prism diopters), with no stereopsis. Occlusion of the fixing eye was carried out in 23 patients for an average period of thirteen months. The squint of 13 of these became alternating, and alternating total occlusion was continued until the day

of operation. Five patients showed no improvement after an average of thirteen months of occlusion. Eight showed an average improvement of 0.2 Snellen (20 per cent) in distance vision after an average of four months of occlusion of the better eye. Three of these continued the occlusion for six months more, but no improvement was seen from further occlusion after the first four or five months. Operation for further correction of the convergence was considered after (1) the child was 4 years old, (2) glasses containing the full atropine correction had been worn for six months and (3) occlusion of the fixing eye had been done for six months, i. e. until alternating fixation was performed at will by the child.

The 30 patients who had convergent squint of 5 to 10 degrees with the glasses on and who therefore did not need operation had unaided an average angle of convergence of 13 degrees but had only 3 degrees with the glasses on. Twelve had right, 17 left and 1 alternating convergent strabismus. The age at which the squint had become manifest averaged 2½ years, ranging from newborn to ten years. All patients except 1 with myopia had compound hyperopic astigmatism when first seen and throughout the period of observation. Synoptoscopic fusion tests showed that 19 of 29 patients had abnormal retinal correspondence. The thirtieth patient could not be so tested by these means. Ten of these patients had an average objective angle at approximately 26 prism diopters of convergence and a subjective angle at 15 prism diopters of convergence, the subjective angle being about 11 prism diopters less convergent than the objective angle. The remaining 9 patients with abnormal retinal correspondence had amblyopia (10/200 to 0.1 vision) in the convergent eye, with suppression of that eye's image over an 18 prism diopter average range. Among the 10 patients with normal retinal correspondence the range was low (18 prism diopters), and none had stereopsis. Twenty-one of these 30 patients with convergent squint were treated by total occlusion of the better eye for an average of five months. Three patients showed no improvement; the others had an average improvement in distance vision of only 0.1 Snellen (10 per cent); i. e., improvement for the group as a whole was negligible.

Fifty-six of the 116 patients with nonaccommodative squint have already been operated on. From the 60 not yet operated on certain conclusions can be drawn:

1. When the squint has developed before the age of 2½ years and is monocular, surgical correction is unnecessary (in 30 of the 60 patients here discussed), because a reduction of the squint to 10 degrees or less can be obtained with glasses.

The better eye is occluded for at least five months in an attempt to produce alternation of fixation and normal vision in the squinting eye.

2. Orthoptic training is of no value when either abnormal retinal correspondence is present (70 of the 116 patients) or subnormal fusion with no stereopsis is present (21 of the 116). Fifty-six of the 116 patients with convergent squint have had to be operated on, and additional surgical correction must be resorted to in the case of 30 of the 60 not yet operated on.

Patients Operated on: The average angle of squint for near objects with the eyes unaided was 30 degrees. In 50 per cent of the patients the angle of squint was improved by the use of glasses (full atropine correction) to 13 degrees. The right eye was affected in 15 and the left in 19, and the squint was alternating in 22. The average age at onset was 2 years (48 cases). Eight of these patients had siblings with convergent strabismus, 6 had recovered from measles recently, 3 had perviously had mastoid operations and 3 others had a history of a fall, whooping cough and scarlet fever, respectively. All had compound hyperopic astigmatism or hyperopia except 2, who when first seen had high myopia.

Synoptoscopic examination of 55 of the 56 patients revealed abnormal retinal correspondence in 45; 34 of these 45 had an average objective angle of 38 prism diopters of convergence and a subjective angle of 20 prism diopters of convergence; i. e., the subjective angle was 18 prism diopters less convergent than the objective angle. Four of these patients had a vertical deviation of right hypertropia averaging 7 prism diopters and 1 had left hypertropia. Postoperative synoptoscopic examination of 23 patients revealed an average objective angle of 21 prism diopters of convergence, with 6 patients having an accompanying vertical deviation. The average vertical tropia was 6 prism diopters; 4 patients had right hypertropia and 2 left. Of the patients operated on, 9 had an average subjective angle postoperatively of 9 prism diopters of convergence. Nine others had suppression over a total area of 31 diopters.

Fusion was found to be present after operation in 10 patients in whom preoperative synoptoscopic examination had been impossible because the angle of squint was greater than 60 prism diopters. The postoperative lateral range of fusion averaged 8 prism diopters. Three of these patients also had a right hypertropia averaging 5 prism diopters. Two had suppression for small targets in the convergent eye over an area of 5 prism diopters. Preoperatively it had been determined that no exercises were indicated for any of these 56 patients with convergent squint requiring surgical correction because (1) a low range of fusion was present in 10 and could not be improved and (2) abnormal retinal correspondence was

present in 45. Total occlusion therapy had been carried out for an average of four months by 22 patients. Ten of these improved about 0.2 Snellen in distance visual acuity. Three had no visual improvement. After an average of three months of total occlusion, 6 patients with amblyopia (0.1 Snellen or less of visual acuity) revealed no improvement or only 0.1 Snellen improvement in distance vision, and this improvement was considered inconsequential. However, the near vision of the amblyopic eye improved from ability to read sight-saving type (24 point print) at 7 inches (18 cm.) to ability to read 8 point print (1.0 D.) at 7 to 8 inches (18 to 20 cm.) in every one of these 6 patients. Total occlusion was carried out for an average of seven months by these patients. The remaining 10 of the 23 patients had occlusion for an average of seven months; in 7 the squint became alternating, whereas in 3 alternating fixation failed to develop.

TABLE 1.—*Type and Number of Operations in 56 Cases of Convergent Strabismus*

External rectus cinch (3 bilateral)	17
External rectus cinch and internal rectus recession	14
External rectus advancement and internal rectus recession	14
Internal rectus recession	13
External rectus cinch and internal rectus tenotomy	2
External rectus cinch and internal rectus graduated tenotomy	2
Internal rectus graduated tenotomy	2
Inferior oblique tenotomy	2
External rectus advancement and internal rectus tenotomy	1
Total	67

A summary of the type and number of surgical treatments is given in table 1. Fifty-one of the 56 patients were "cured"; i. e., a satisfactory cosmetic correction was obtained (a convergent angle of 1 to 5 degrees for near objects and no divergence for distant objects). Two to six months after the operation 10 of the 51 "cured" patients had a divergent squint for distance with the glasses on. The treatment of these 10 was simply removal of the glasses, and the result was a 3 to 5 degree convergence for distant and for near objects with no complaint from the patient. Forty-two of the "cures" occurred after the first operation; 26 of the patients required no glasses postoperatively, 3 required glasses for near work only and 13 needed the glasses all the time. Fourteen patients required a second operation, and 9 "cures" resulted. Three of the patients with a final "cure" required no glasses, 2 required glasses for near work only and 4 needed glasses all the time.

Five of the 56 patients on whom operation was performed need still further surgical treatment to obtain cosmetic correction (angle of squint less than 10 degrees); 3 require a second operation and 2 a third oper-

ation. One patient does not need surgical intervention but has had a constant diplopia for the two years since the operation. She has fusion at only one point, namely 5 prism diopters of convergence with 8 prism diopters of left hypotropia. At all other times this patient, a woman 26 years old, has alternating fixation and cannot suppress her second image.

The average correction in the degrees of squint effected by the first operation was 19 degrees; the resultant convergence angle was 12 degrees with the eyes unaided and 5 degrees with the glasses on. The patients who underwent the second operation secured an average of 14 degrees further improvement with an average resultant convergence angle of 10 degrees without glasses and of 7 degrees with the glasses on.

Comment: This experience with 116 patients with nonaccommodative squint would indicate that:

1. Patients with convergent squint of 10 degrees or more for objects at 14 inches (35 cm.) with the glasses on require before operation a trial of at least six months' wearing of the full atropine correction and total occlusion of the better eye for six months.

2. Surgical correction is indicated for every 4 year old child in whom a squint of 10 or more degrees persists after six months of wearing glasses containing the full correction and six months of total occlusion of the better eye.

3. Orthoptic fusion training exercises are of no avail, either preoperatively or postoperatively, in the treatment of nonaccommodative convergent strabismus. Indeed, they are contraindicated in my opinion, because they act as a disturbing element to the adjustment which the individual patient naturally makes to his abnormal retinal correspondence. By his adjustment he has avoided diplopia. The patients here discussed show conclusively that patients with nonaccommodative strabismus have only a small amount of fusion if they have any at all; i. e., their fusion is subnormal. It (*a*) is of defective amplitude and (*b*) cannot be improved. Abnormal retinal correspondence therefore seems to be simply the patient's adjustment to insure him against diplopia. Orthoptic fusion exercises for such patients have as their first aim, by retinal massage of the maculas, creation of diplopia and as their next aim the development of fusion of the two macular images, and it is found that this fusion cannot be developed.

Yet, notwithstanding the absolute futility of this "massage" treatment in all of our 45 cases of abnormal retinal correspondence, examination with the major amblyoscope, i. e. the synoptoscope, is of the utmost value in diagnosis and prognosis. Indeed, it is necessary and essential in the correct evaluation of imbalance of the extraocular muscles in every case.

C. *Divergent Strabismus (Twenty-One Patients).*—Of the 21 patients with divergent strabismus, 18 had monocular squint, 7 right and 11 left. In 16 the divergence was greater for distant objects; in 5 it either was not present for distant objects or was the same for distant and for near objects. The divergence began between birth and the age of 1 year in 7 cases and between the ages of 2 and 5 years in 6 cases, with no history obtainable as to the age of onset in 8 other cases.

Each patient was examined during atropine cycloplegia. Compound hyperopic astigmatism was found in 17, compound myopic astigmatism in 2 and mixed astigmatism in 2, and anisometropia (i. e. difference of about 3 D. of spherical refraction) was present in 6 patients with monocular divergent squint, 5 with the left and 1 with the right eye affected. One patient with alternating divergent strabismus had anisometropia. In all 6 of these patients with monocular divergence, the divergent eye had the higher refractive error, but oddly enough in only 2 was there poor vision in the deviating eye, i. e. 0.2 and 0.3 Snellen. Only the patients with mixed astigmatism and myopic astigmatism received glasses; i. e. no patient with compound hyperopic astigmatism or hyperopia received glasses.

Examination on the synoptoscope revealed that 12 of the 21 patients had fusion. The fusion point of simultaneous macular perception ranged from zero to 22 prism diopters of divergence, with the average point at 11 prism diopters of divergence. The amplitude of fusion extended from 20 diopters of divergence to 25 prism diopters of convergence. The average range of fusion was 9 prism diopters. Two of the 12 patients had 100 per cent stereopsis with Keystone View Betts card DB6 as a standard. The other 10 failed in the test for stereopsis. Abnormal retinal correspondence was demonstrated in 7 of the 21 patients with divergent squint. Four of these had a hypertropia of the deviating eye measuring 2 to 8 prism diopters. Two more patients had abnormal retinal correspondence resulting from a loss of fusion while under our observation.

On the synoptoscope in March 1939 one of these showed fusion at 10 prism diopters of divergence. There was a low range of fusion, i. e. 12 prism diopters of divergence to 2 prism diopters of convergence. In August 1939 abnormal retinal correspondence was demonstrated, with the objective angle at 18 prism diopters of divergence and the subjective angle of 14 prism diopters of divergence. This has persisted to the time of writing (December 1940). In April 1939 the other patient showed fusion at 22 prism diopters of divergence, with a range of 13 to 9 prism diopters of divergence. Five months later the synoptoscope revealed abnormal retinal correspondence, and this has persisted to the time of writing (December 1940) with the objective angle at 20 prism diopters of divergence and 4 prism diopters of left hypertropia.

The remaining 2 patients of the total of 21 were too young (2 years old) to test for fusion.

Treatment: The treatment was of course dependent on the results of the previously mentioned examinations. Each patient was given individual consideration and advice as to (1) orthoptic exercises at the clinic, (2) convergence exercises at home, (3) use of a temporary vertical prism hanger if hypertropia was present and (4) surgical correction.

1. Orthoptic exercises: The patients were given orthoptic exercises on the synoptoscope, from two to ten in number, all within three weeks' time and of a half-hour's duration. Only 2 patients had a "cure" by orthoptic exercises, one after four exercises on the synoptoscope and the other after twelve exercises on the Lloyd stereocampimeter. These 2 patients were finally able to overcome 48 prism diopters base out on the Lloyd stereocampimeter. However, the first patient undertook orthoptic exercises after her own request for an ophthalmic operation was granted. A cinch operation on the internal rectus muscle had been performed in which eight strands of 000 dermal suture were applied to four horizontal strips of the muscle tendon in double loops by the routine O'Connor technic.

2. Convergence exercises: Two small children were instructed in convergence exercises at home. The parent gave the exercises with a pocket flashlight twice a day, having the convergence effort performed ten times at each sitting. Each child had an occasional divergent squint and a remote near point of convergence. The results were gratifying, for each child showed definite, sustained improvement. The data are as follows:

M. V., aged 2 years, had a PcB [17] of 125 mm. After six months of convergence exercises at home (ten times twice daily) the PcB was 50 mm. The synoptoscope, however, persistently revealed abnormal retinal correspondence, with the objective angle at 25 prism diopters of divergence and an indefinite subjective angle.

B. S., 4 years old, had a PcB of 120 mm. After three months of convergence exercises at home the PcB was 100 mm. The synoptoscope showed fusion at one point only, at 20 prism diopters of divergence; i. e. there was no range of fusion.

The parents of each child have been advised to have surgical correction of the divergence when the child is 4½ years old.

3. Vertical prism treatment: One child wore a temporary vertical prism for correction of the vertical deviation which accompanied the

17. Pc is the proximate convergence (near point) measured from the anterior focal point (13.5 mm. anterior to the cornea). B is the center of rotation of the eye, 11.5 mm. posterior to the cornea. PcB is the proximate convergence: Pc + 13.5 mm. + 11.5 mm. The average normal PcB is 70 to 100 mm. for adults and 40 to 70 mm. for children.

divergent squint for near objects. No squint was present for distant objects. There were a remote PcB (190 mm.), 1.5 prism diopters of left hyperphoria and 8 prism diopters of left divergent strabismus for near objects. A prism hanger of 0.75 prism diopter base up in the right lens and 0.75 prism diopter base down in the left lens was worn for near objects over a period of six months, and convergence exercises were carried out at home. The PcB improved to 135 mm. The range of fusion improved from an original 13 to 23 prism diopters. However, it was felt that an operation would help further.

4. Surgical treatment: Surgical therapy was advised for 19 of the 21 patients with divergent squint. Four refused to consider it. Six patients underwent operation, and 4 of these require a second operation owing to undercorrection. Nine are awaiting their first operation.

Of the 6 patients who received surgical care, 5 had an O'Connor cinch operation on the internal rectus muscle of the deviating eye. Four of these had eight strands of dermal suture material with four horizontal strips of muscle tendon in double-looped fashion. One other patient had the eight strands of dermal suture material with three horizontal strips of muscle tendon in double-looped fashion. The sixth patient had a cinch operation on both internal rectus muscles. In the patients operated on the original divergence was 10 to 30 degrees, with an average of 21 degrees. The average amount of correction obtained was 10⅞ degrees. As stated, 4 of the 6 patients will need a second operation to correct the divergence more fully.

Conclusions Concerning the Care of Patients with Divergent Squint: From this study one may conclude that for divergent squint orthoptic exercises under clinic supervision are justified only if there is a moderately low range of fusion (about 10 prism diopters). The value of pencil convergence exercises at home is limited to the few patients with occasional divergent squint found to have a remote near point of convergence. The use of a prism hanger to correct the vertical deviation accompanying divergence in some patients is of questionable value. The treatment of divergent squint is for the most part surgical, sooner or later. From the operative results in 6 cases it may be concluded that recession of the external rectus muscle should be done first and a shortening operation on the internal rectus muscle considered secondarily in all cases of divergent squint when deviation is greater for distant than for near objects.

II. ALLIED CONDITIONS

A. *Anisometropia.*—Five of the 192 patients lacked manifest strabismus and showed only anisometropia and blunted vision in the more anomalously refractive eye. The results of the examinations and of the therapy are best shown by a table (table 2). All 5 received glasses containing the full correction, and 4 received occlusion therapy. None received synoptoscopic therapy.

Unfortunately, the visits to the orthoptic clinic considered necessary for the 5 patients were impossible. Such a small group does not of course warrant wide-going conclusions, but from the experience available it is felt that orthoptic training should be given a trial, after full correction of the refractive error and six to eight months of total occlusion of the better eye, in an attempt to improve the subnormal range of fusion, found in all these patients.

B. *Poor Vision in One Eye or Reading Difficulty.*—The 5 patients with poor vision or poor reading ability revealed on examination only a slightly subnormal range of fusion of 32 prism diopters and 70 per cent stereopsis. No orthoptics were indicated.

TABLE 2.—*Summary of 5 Cases of Anisometropia*

Age of Patient, Yr.	Refractive Error (Atropine Cycloplegia)	Synoptoscopic Range of Fusion (With Glasses on)	Stereopsis, Percentage	Occlusion Therapy
10	R: +8.00 ⌒ +1.75, axis 70 = 0.1 L: +3.00 ⌒ +1.50, axis 75 = 0.5	8△ divergence to 5△ convergence	0	Impossible
11	R: +1.75 ⌒ +0.50, axis 90 = 1.5 L: +4.00 ⌒ +0.75, axis 75 = 0.3	Zero to 35△ convergence; right, suppression of small targets from 5△ to 10△ convergence	0	Occlusion on right, 2 mo.; no improvement
9	R: −2.00 ⌒ +4.50, axis 100 = 0.5 L: +0.50 ⌒ +0.50, axis 90 = 1.5	3△ divergence to 20△ convergence	60	Occlusion on left, 4 mo.; vision, right eye, 0.8
9	R: +0.50 ⌒ +3.50, axis 90 = 0.5 L: −0.25 ⌒ +5.25, axis 90 = 0.4	5△ convergence to 20△ convergence	70	Not indicated
10	R: +1.00 ⌒ 1.2 L: +6.00 ⌒ +1.00, axis 90 = 0.5	Zero to 10△ convergence; left, suppression of small targets from 5△ divergence to 5△ convergence	20	Occlusion on right, 12 mo.; vision, left eye, 0.8

CONCLUSIONS CONCERNING THE 182 CASES OF STRABISMUS

Pure orthoptic ("fusion") training exercises (exclusive of occlusion of one eye, use of glasses and prisms and surgical procedures on the eye) undertaken and carried out in 182 cases of strabismus (161 of convergent and 21 of divergent strabismus) under thoroughly favorable conditions as to length of observation and number of visits, cooperation of parents, equipment of the clinic and daily time devoted to the work by a trained ophthalmologist were a failure in 180 cases and therefore practically a complete failure. Two patients with divergent strabismus were benefited.

In detail it was found that:

1. The attempt to improve the range of fusion (which showed an average [low] range of 21 prism diopters vs. an assumed normal of 40) in 37 of 45 cases of accommodative convergent squint (normal retinal

TABLE 3.—*Summary of 182 Cases of Strabismus*

		Convergent Squint (161 Cases)				
		Accommodative Type (Eyes Straight with Glasses; 45 Cases)	Nonaccommodative Type (Eyes Convergent with Glasses, 116 Cases)			
			Operation Still Necessary (30 Cases)	Operation Not Necessary (30 Cases)	Operation Performed (56 Cases)	Divergent Squint (21 Cases)
Age of onset, yr		2½	1½	2½	2	2
Refractive error		39, compound hyperopic astigmatism 5, hyperopia 1, mixed astigmatism	Compound hyperopic astigmatism	29, compound hyperopic astigmatism 1, myopia	54, compound hyperopic astigmatism 2, myopia	17, compound hyperopic astigmatism 2, compound myopic astigmatism 2, mixed astigmatism
Eye affected	Right	13	11	12	15	7
	Left	29	10	17	19	11
	Alternating	3	9	1	22	3
Angle of squint for near vision	Unaided	14° convergence	26.6° convergence	13° convergence	30° convergence	16° divergence
	with glasses	None	20.0° convergence	3° convergence	23, no improvement; 23, 13° convergence	
Synoptoscopic fusion tests	Abnormal retinal correspondence	3, objective angle, 13 △ convergence; subjective angle, 3 △ convergence 1, objective angle, 10 △ convergence; suppression, 15 △	17, objective angle, 40 △ convergence; subjective angle, 27 △ convergence	10, objective angle, 26 △ convergence; subjective angle, 15 △ convergence 9, objective angle, 15 △ convergence; amblyopia; suppression, 18△	45, objective angle, 38 △ convergence; subjective angle, 20 △ convergence	9, objective angle, 18 △ D.; subjective angle, ?
	Fusion	37, low range, 21 △	1, low range, 13 △	10, low range, 18 △	(postoperative) 10, low range, 8△	12, low range, 9 △
	Stereopsis	40%	None	None	None	10, none; 2, 100%
Comment		After 3 years of glasses, 20 patients had no squint, with the eyes unaided, for distance or for near vision; age of "outgrowth," 6½ to 8 yr.			21 (postoperatively), abnormal retinal correspondence; objective angle, 21 △ convergence; 9, subjective angle, 9 △ convergence; 9, suppression, 31 △ convergence; 3, subjective angle ?	
Total occlusion	Cases	13	23	21	24	
	Duration, months	5	13	5	6	
	Improved vision (Snellen)	9, 0.2	8, 0.2	9, 0.1	8, 0.2	
	No improvement	2	5	3	5	
Results of orthoptic training		Failure in all	Failure in all	Failure in all	Failure in all	"Cure" in 2 cases; failure in all others

correspondence in 37, abnormal retinal correspondence in 4 and patient too young to test, i. e. under 2, in 4) was virtually a total failure. The range could not be improved more than 10 prism diopters in any one of the 37 cases. Of the other 8 of the 45, abnormal retinal correspondence was present in 4 and the patient too young to be tested (under 2) in 4.

2. The attempt to develop the faculty of fusion was likewise unsuccessful in every one of 94 cases of strabismus with abnormal retinal correspondence (4 of accommodative convergent, 81 of nonaccommodative convergent and 9 of divergent strabismus). Fusion training (carried out consistently and thoroughly) therefore failed in 162 of a possible 182 cases, or 88 per cent.

It is therefore concluded that orthoptic training is of no value, either preoperatively or postoperatively, in abnormal retinal correspondence. And abnormal retinal correspondence was found in 85 of the 161 cases of convergence (over 50 per cent), in 9 of the 21 cases of divergence (over 40 per cent) and thus in 94 of a total of 182 cases of strabismus (over 50 per cent). There seem to be two main reasons for this frequency. One is that patients with accommodative convergent squint have a stubborn congenitally subnormal fusion range which cannot be improved to any appreciable extent by orthoptics, and the other is that attempts to produce fusion at one point (the objective angle) result in diplopia at all other points.

The 5 patients with anisometropia without strabismus had the same type of subnormal, unresponsive fusion faculty. Five additional patients with reading difficulty (without strabismus) had a slightly subnormal range of fusion (32 prism diopters) and did not need fusion training.

On the other hand, the major amblyoscope, i. e. the synoptoscope, is of inestimable value in cases of strabismus and anisometropia as a diagnostic and prognostic instrument both in preoperative and in postoperative study.

The diagnosis of abnormal retinal correspondence, made by synoptoscopic examination, at once justifies a bad and very guarded prognosis that any degree (whatever) of fusion can be developed no matter what type of therapy is carried out. On the other hand, a trial of orthoptic exercises is indicated in cases of accommodative convergent strabismus, divergent strabismus and anisometropia provided the range of fusion is low. Some (about 20 per cent) of the patients with accommodative convergent and more of those with divergent strabismus had abnormal retinal correspondence and others (about 75 per cent) had a low range of fusion.[18]

950 East Fifty-Ninth Street.

18. The value of orthoptic exercises in the treatment of phorias will be discussed in a future paper.

LYMPHOSARCOMA OF THE LACRIMAL GLAND

REPORT OF A CASE WITH GIANT LYMPH FOLLICLE HYPERPLASIA

CHARLES A. PERERA, M.D.
NEW YORK

About 5 per cent of primary tumors of the lacrimal gland arise from its lymphoid tissue. These must be distinguished from adjacent lymphoid growths which invade the gland and from secondary metastatic neoplasms of the lymphatic system, such as those of chloroma, lymphatic leukemia, Hodgkin's disease and generalized lymphosarcoma. A thorough survey of the scientific literature by Laura A. Lane [1] in 1922 uncovered only 229 examples of tumor of the lacrimal gland. These included the cases gathered by Warthin [2] in 1901 and by Greeves [3] in 1914 and included a case of lymphosarcoma of the lacrimal gland reported by Vollaro [4] in 1899.

Wells and Mayou [5] in 1910 described a case of lymphosarcoma of the lacrimal gland in a woman of 66 and stated that they had found 11 similar cases in the literature. Of these, there were certain uniform characteristics in 9: The patients were all over 38, the growth showed no preference as to sex or as to side of the body, the lymph nodes were not enlarged, a tendency to infiltrate and invade surrounding structures was evident and the neoplastic process grew slowly. Francis [6] presented

---

Presented before the New York Academy of Medicine, Section of Ophthalmology, Nov. 17, 1941.

From the Department of Ophthalmology, Columbia University College of Physicians and Surgeons, and the Institute of Ophthalmology, Presbyterian Hospital.

1. Lane, L. A.: A Study of Tumors of the Lacrimal Gland, with Report of a Mixed Tumor, Am. J. Ophth. **5**:425-434 (June) 1922.

2. Warthin, A. S.: A Case of Endothelioma of the Lachrymal Gland (Myxo-Chondro-Endothelioma Cylindromatodes), with an Analysis of Previously Reported Cases of Lachrymal Gland Tumors, Arch. Ophth. **30**:601-620, 1901.

3. Greeves, R. A.: Primary New Growths of the Lachrymal Gland, Roy. London Ophth. Hosp. Rep. **19**:237-263, 1914.

4. De Lieto Vollaro, A.: Di un linfosarcoma della glandola lagrimale, Ann. di ottal. **28**:133-146, 1899.

5. Wells, A. P. L., and Mayou, M. S.: Lympho-Sarcoma of the Lacrimal Gland, Tr. Ophth. Soc. U. Kingdom **30**:97-101, 1910.

6. Francis, L. M.: A Case of Malignant Lymphoma of the Lacrimal Gland, Tr. Am. Acad. Ophth. **27**:138-148, 1922.

a case of "malignant lymphoma" of the lacrimal gland in 1922 and added a large bibliography dealing with growths of the lacrimal gland. His patient, a white woman of 51, was alive and well two years after surgical removal of the growth through an incision below the brow. Fehler [7] in 1922 briefly reported a case of generalized lymphosarcoma which began with exophthalmos on the right due to a tumor of the lacrimal gland. In 1925 Pfingst [8] described 3 cases of tumor of the lacrimal gland; the third patient was a woman aged 53 with a small round cell tumor diagnosed as lymphoblastoma (lymphoma); she was apparently cured after excision of the growth, having been followed for three years.

The giant follicle lymphadenopathy described by Brill, Baehr and Rosenthal [9] in 1925 as a generalized lymph follicle hyperplasia of the lymph nodes and spleen has been reported by Symmers,[10] Baehr and Klemperer [11] and Mayer and Thomas.[12] This disease is considered to be a form of lymphosarcoma, or malignant lymphoma. Recently, Gall, Morrison and Scott [13] reviewed 63 cases, dividing the tumors into four histologic types. Sugarbaker and Craver,[14] in an excellent study of lymphosarcoma, presented the results of observation of 196 cases proved by biopsy; of these, the diagnosis in 9 was giant follicle lymphoma.

M. C. Wheeler,[15] in 1938 reported on an elderly man with lymphosarcoma of the lower eyelid and the orbit. The growth had been noticed

7. Fehler, H.: Ueber eine von der Tränendrüse ausgegangene Lymphosarkomatose, Klin. Monatsbl. f. Augenh. **99**:92 (July) 1937.

8. Pfingst, A. O.: Neoplasms of the Lacrimal Gland, with Report of Three Cases, Tr. Am. Ophth. Soc. **23**:33-50, 1925.

9. Brill, N. E.; Baehr, G., and Rosenthal, N.: Generalized Giant Lymph Follicle Hyperplasia of Lymph Nodes and Spleen, J. A. M. A. **84**:668 (Feb. 28) 1925.

10. Symmers, D.: Certain Clinical and Pathologic Aspects of Lymphosarcoma, Am. J. M. Sc. **174**:9 (July) 1927; Follicular Lymphadenopathy with Splenomegaly, Arch. Path. **3**:816 (May) 1927; Giant Follicular Lymphadenopathy With or Without Splenomegaly, ibid. **26**:603 (Sept.) 1938.

11. Baehr, G., and Klemperer, P.: Giant Follicle Lymphoblastoma: Benign Variety of Lymphosarcoma, New York State J. Med. **40**:7-11 (Jan. 1) 1940.

12. Mayer, S., Jr., and Thomas, H. M., Jr.: Follicular Lymphoblastoma and Related Forms of Lymphosarcoma, Bull. Johns Hopkins Hosp. **64**:315-338 (May) 1939.

13. Gall, E. A.; Morrison, H. R., and Scott, A. T.: The Follicular Type of Malignant Lymphoma: A Survey of Sixty-Three Cases, Ann. Int. Med. **14**: 2073-2090 (May) 1941.

14. Sugarbaker, E. D., and Craver, L. F.: Lymphosarcoma: A Study of One Hundred and Ninety-Six Cases with Biopsy, J. A. M. A. **115**:17-23 (July 6); 112-117 (July 13) 1940.

15. Wheeler, M. C.: Malignant Neoplasm of the Eyelid, Arch. Ophth. **20**:682 (Oct.) 1938.

two months before its surgical removal. Microscopic study showed it to be surrounded by a delicate capsule. The neoplasm consisted of masses of small round cells, among which were large, paler areas resembling atypical germinal centers. The microscopic picture of this growth was similar to that of the tumor of the lacrimal gland reported in this paper. Wheeler's patient, followed for over one year, had no recurrence of the growth.

The case described hereafter is of great interest not only because of the rarity of the condition but because of the opportunity offered for speculation on the malignant neoplastic diseases of the lymphatic system.

REPORT OF CASE

B. G., a 58 year old white woman of German extraction, had been under the care of Dr. Charles H. May for twenty-four years. She had been treated for mild chronic catarrhal conjunctivitis on several occasions and had received prescriptions for glasses to correct a small amount of compound hyperopic astigmatism and presbyopia.

I saw her first in April 1937, when she complained of a slight irritation of her left eye. This was ascribed to the conjunctivitis, since the remainder of the ocular examination gave negative results. Three weeks later she returned, stating that her left eye had become more prominent during the previous two weeks. Her past medical history and her family history were irrelevant.

Examination showed exophthalmos on the left of 5 mm., a small amount of right hyperphoria increasing on downward gaze to the right side and a palpable mass in the region of the left lacrimal fossa and behind the left lateral palpebral ligament (fig. 1). The exophthalmos was not replaceable. There was no bruit. Vision was 20/15 in each eye with glasses.

The patient was admitted to the Institute of Ophthalmology of Presbyterian Hospital, where a complete physical examination revealed normal conditions except for the ocular abnormalities. There was no enlargement of lymph nodes. The spleen was not palpable. Roentgenologic studies of the orbits, optic canals and skull by Dr. R. L. Pfeiffer showed a slight increase in the density of the soft tissue of the left orbit but no evidence of involvement of bone. The blood count showed: erythrocytes 4,800,000, hemoglobin 95 per cent and white cells 10,000 (polymorphonuclear leukocytes 67 per cent, small lymphocytes 25 per cent, Türk cells 6 per cent and eosinophilic leukocytes 2 per cent). A diagnosis of tumor of the left lacrimal gland was made and operation advised.

With the patient under general anesthesia with avertin and ether, the left orbit was explored by the external canthotomy and transconjunctival route, the globe being retracted nasally. A firm, rubbery, encapsulated tumor was encountered in the lacrimal fossa; it had a posterior extension which reached to the apex of the orbit. The growth was freed from the periosteum and the lateral rectus muscle by blunt dissection and a few snips of the scissors and removed. The lateral rectus muscle was preserved intact. The lateral palpebral ligament was sutured, and the conjunctival and the cutaneous incision closed with interrupted silk sutures. Healing was uneventful, and the patient was discharged from the hospital after six days. Moderate blepharoptosis on the left and considerable impairment in motility of the left eyeball were present; these disappeared entirely by the end of two months after operation.

A pathologic study of the specimens showed the main growth (fig. 2) to measure 28 by 28 by 11 mm. It was rubbery and yellowish on cross section. Microscopic examination revealed that the main tumor mass consisted of small,

Fig. 1.—The patient, showing prominence of the left eye.

Fig. 2.—Hemisection of the tumor removed from the left lacrimal fossa.

closely packed cells with round, deeply staining nuclei and scanty cytoplasm. Scattered through the tumor were large circular or oval areas containing large, pale-staining cells, endothelioid in structure, with large nuclei which varied in size (figs. 3 and 4). The appearance of the tumor was that of an atypical giant

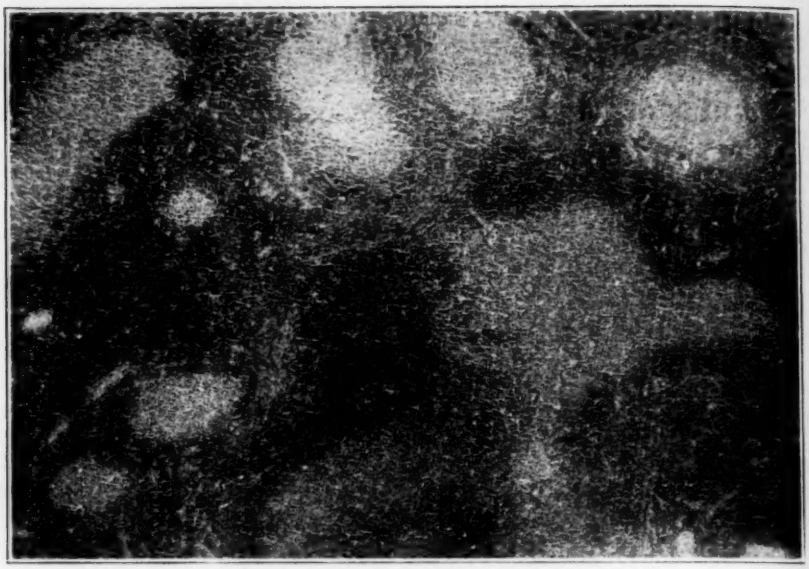


Fig. 3.—Appearance of the tumor under low power magnification. Note the dark areas of closely packed round cells and the pale areas of atypical germinal centers.

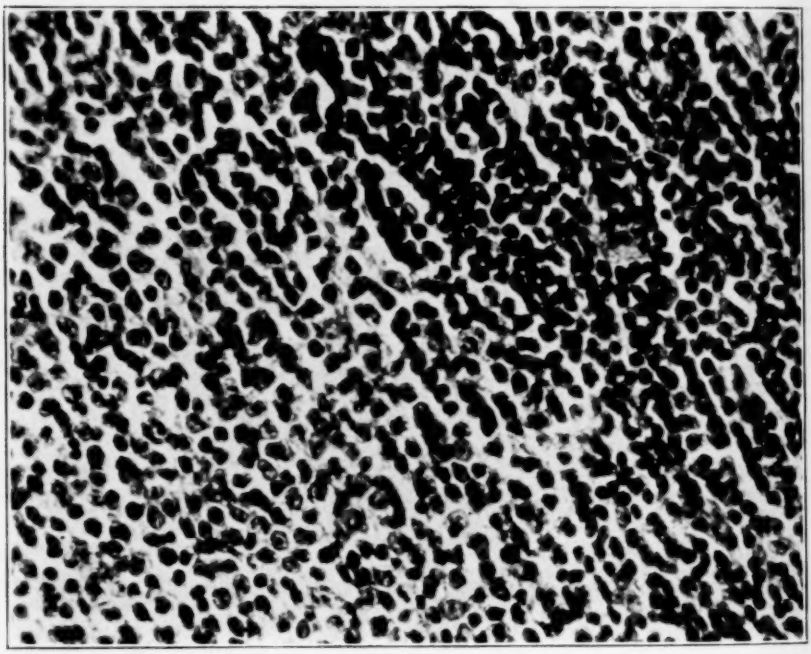


Fig. 4.—High power photomicrograph of a small area of the tumor, showing the margin of a germinal center. Note the lymphocytes in the upper right and the endothelioid cells in the lower left half of the illustration.

lymph follicle. Occasional mitotic figures were seen, as well as a few eosinophils. The numerous capillaries which were present contained proliferation of their endothelium. The growth showed little stroma, although thin connective tissue septums containing blood vessels extended through the tumor mass. There was a definite fibrous capsule which was invaded and penetrated by tumor cells of the small lymphocytic variety. A small lobule of normal lacrimal gland tissue was found at one extremity of the tumor (fig. 5). The Laidlaw reticulum stain revealed a scant reticulum. A second fragment of tissue removed from the orbit posterior to the main mass in the lacrimal fossa showed connective tissue infiltrated with small round cells and a body of tumor identical with the main large specimen. My diagnosis of lymphosarcoma (giant follicle lymphoma) was confirmed by Dr. A.

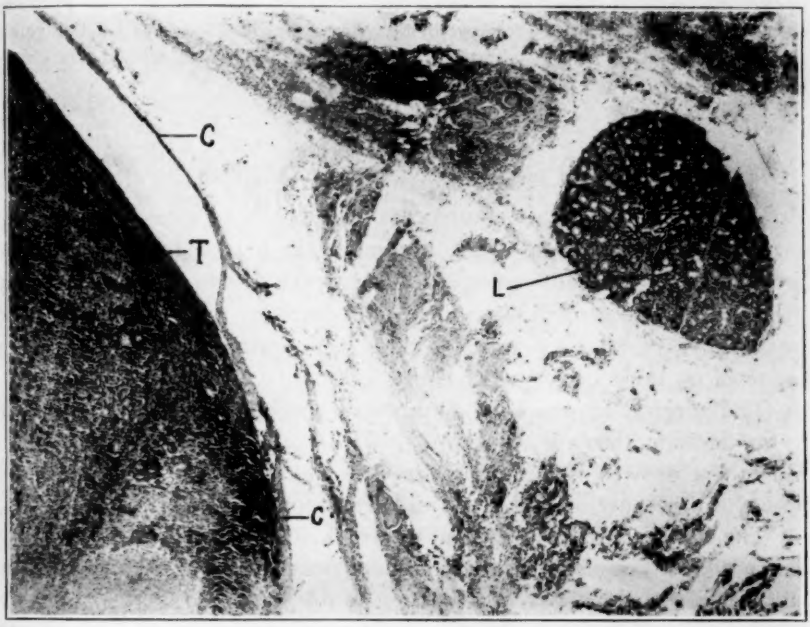


Fig. 5.—Photomicrograph of the border of the tumor (*T*) showing the fibrous capsule (*C*) and an adjacent lobule of lacrimal gland tissue (*L*).

P. Stout, who reported: "I believe that this is a lymphosarcoma of the giant follicle type. This is a tumor of relatively slow course which is nevertheless a malignant growth and may in the end destroy the host. The patient should be watched for local reappearances and also for possible involvement of the lymphoid structures in other areas, especially the lymph nodes and the spleen."

Dr. Fred W. Stewart examined the microscopic slides and stated: "Such lesions of the orbit may not be placed in the same clinical category as those of nodes. Were this lesion in a node, one would call it a giant follicle lymphoma and expect it to generalize and have a fatal outcome. Since it is in the orbit, one is justified only in calling it lymphogranuloma and may anticipate a benign course. I believe such lesions when in the orbit often replace portions of the lacrimal gland, which undergo complete atrophy, and that in this respect they may be compared to the lesions of struma lymphomatosa, or Hashimoto's disease of the thyroid."

The patient was referred to Dr. Hayes Martin for roentgen therapy, the first treatment being given seven days after operation. Dr. Martin reported: "I treated the patient by external irradiation, giving nine treatments of 500 roentgens each three times a week for a total of 4,500 roentgens over a period of about three weeks. The other physical factors were: 250 kilovolts, a 0.5 mm. copper filter, a 35 cm. target-skin distance and a 3 cm. circular portal. Following this treatment, there was a blistering radiation reaction of moderate degree under the skin portal."

During the four and one-half years since operation, the patient has been examined at intervals of from two to six months. The vision of her left eye has been reduced to 20/25 as a result of a small lenticular opacity in the anterior-inferior part of the cortex associated with a reduction in the hyperopia of this eye. Enophthalmos of the left eye of 3 mm. has been present since one month after operation. Several thorough physical examinations have revealed no systemic abnormalities except severe osteoarthritis. Roentgenologic studies of the pelvis and lumbar portion of the spine by Dr. Eugene R. Kraus showed severe osteoarthritis but no evidence of metastatic disease of the bones.

COMMENT

The treatment of orbital tumors has recently been discussed by A. B. Reese.[16] His paper contained a brief report of 5 cases of lymphosarcoma of the orbit from the collection in the pathology department of the Institute of Ophthalmology. The average age of the 5 patients at discovery of the growth was 55. Three patients died within two and one-half years after operation. The 2 surviving patients are those reported on by Wheeler and by me.

The surgical approach to a tumor of the lacrimal gland is usually by an incision through the skin below the outer part of the eyebrow. When the growth is extensive or orbital exploration is required, the lateral canthotomy and transconjunctival approach is adequate.

The classification of neoplasms of lymphoid tissue is confused because of the difficulty in drawing sharp lines of demarcation between the types and because of the apparent transition of one type into another. There is a lack of uniformity in the nomenclature of these tumors. The terms malignant lymphoma, lymphoblastoma, lymphocytoma and lymphosarcoma seem to have been used to describe similar or even identical lesions.

A tumor of lymphoid tissue may arise from the reticular or from the endothelioid cells of the germinal centers and from the small lymphocytes arranged around them, giving rise to reticular cell lymphosarcoma or malignant lymphocytoma, respectively. The tumor may occur as a localized or as a diffuse process. Ewing[17] divided lymphoid growths into three categories: (1) lymphadenoma, including multiple giant follicle lymphadenopathy and gastrointestinal pseudoleukemia; (2)

16. Reese, A. B.: Orbital Tumors and Their Surgical Treatment, Am. J. Ophth. **24**:386-394 (April); 497-502 (May) 1941.

17. Ewing, J.: General Pathology of Lymphosarcoma, Bull. New York Acad. Med. **15**:92-103 (Feb.) 1939.

lymphocytoma, including systemic pseudoleukemia, lymphocytic leukemia, malignant disseminating lymphocytoma, plasmacytoma and solitary lymphoma, and (3) reticular cell lymphosarcoma.

The localized and the generalized giant follicle type of tumor of the lymphatic system occur in an older age group than does lymphosarcoma of other kinds. The duration of the giant follicle types is longer, and hematologic abnormalities are unusual. Although lymphoid tumors are fairly radiosensitive, the giant follicle type is especially so.

Localized giant follicle tumor of the lymphoid tissue when found in the orbit is a relatively benign neoplastic process and in the early stage at least responds to treatment with a combination of surgical intervention and radiotherapy. However, it seems advisable to consider this type of growth as a potential setting for generalized lymphosarcoma.

SUMMARY

The scientific literature dealing with lymphoid tumors of the lacrimal gland is reviewed, and a case of giant follicle lymphosarcoma of the lacrimal gland is presented. The growth was found in a white woman of 58 who showed an irreplaceable exophthalmos of 5 mm. and a small amount of hyperphoria. After surgical removal of the tumor and roentgenotherapy to the involved orbit, an apparent cure was obtained, the patient being alive and well more than four and one-half years after operation. I consider localized giant follicle tumor of the lymphoid system in the orbit a relatively benign lesion although potentially capable of giving rise to generalized lymphosarcoma.

Mr. A. Marfaing took the photographs and Mr. N. Ross the photomicrographs.

70 East Sixty-Sixth Street.

News and Notes

EDITED BY DR. W. L. BENEDICT

GENERAL NEWS

Station to Check Tonometers.—A station for checking the accuracy of Schiøtz tonometers is temporarily located at the offices of the National Society for the Prevention of Blindness, Room 1300, 1790 Broadway, New York, under the direction of Dr. Adolph Posner. Inquiries about this service will be welcomed.

CORRECTIONS

In the article by Drs. H. L. Caveness, G. H. Satterfield and W. J. Dann entitled "Correlation of the Results of the Biophotometer Test with the Vitamin A Content of Human Blood," which appeared in the May 1941 issue (ARCH. OPHTH. **25:** 827, 1941), the second paragraph of the summary should read: "The mean and standard deviation for the figures per hundred cubic centimeters of plasma were: carotene, 138 ± 62 micrograms; vitamin A, 62 ± 17 U. S. P. units, and total biologic activity, 292 ± 107 U. S. P. units."

In the transactions of the April 23 meeting of the Detroit Ophthalmological Society, published in the August issue (ARCH. OPHTH. **28:** 368, 1942), the last paragraph of Dr. Harvey E. Dowling's report entitled "Treatment of Amblyopia ex Anopsia" (line 17 on page 370) should begin "Occlusion of the fixing eye."

In the article by Dr. Sidney A. Fox entitled "Traumatic Myopia with Hypotony," in the August issue (ARCH. OPHTH. **28:**218, 1942), the word "hypertony" in the next to the last line on page 225 should be "hypotony."

Obituaries

EMIL von GRÓSZ, M.D.
1865-1941

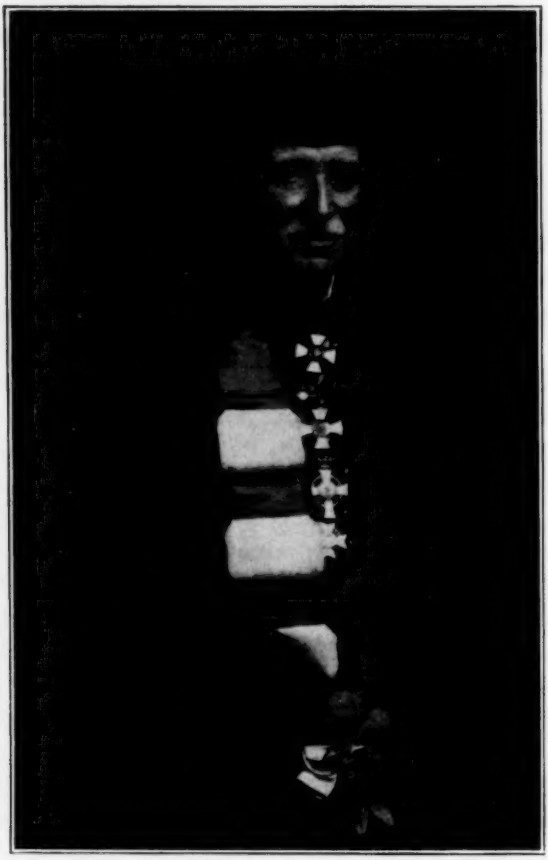
An internationally prominent ophthalmologist and a great organizer, Emil von Grósz died on Dec. 8, 1941, in Budapest, Hungary. Grandson and son of ophthalmologists, he was born on Sept. 30, 1865 in Nagyvárad, Hungary, where his grandfather founded the first charity ophthalmic hospital in Europe (1830). The family tradition in ophthalmology, his knowledge of languages, his energy and his friendly personality were only contributing factors to his fame and success, of which his medical knowledge and surgical skill were the real basis.

After graduating from the medical school of the University of Budapest he took a course in public health and entered the ophthalmic clinic of his alma mater. Advancing rapidly through the ranks of the clinic, he became the head of it in 1904 and remained in this position until his retirement in 1936. In 1914 he was dean of the medical faculty, being one of its most active members. An excellent teacher, he always adjusted himself to the mental level of his audience, wherever he lectured. His eye was on everything in his clinic, which at the time of his retirement consisted of 136 beds. The yearly number of new outpatients averaged 22,000; hospital admissions, 1,800; major operations, 1,600, and the number of cataract operations, 400. He was proud of the clocklike schedule of his clinic. "The point of the cataract knife enters the anterior chamber at the stroke of eight o'clock." He had the reputation of being a conservative surgeon, a clever policy in view of the large surgical material. The number of his scientific contributions runs into hundreds, most of them being in the field of trachoma and of ophthalmic surgery. He considered the daily press to be a potent factor in focusing the interest of the public on questions of public health and on the problems of the university.

The activities of a university professor would have been sufficient to keep him fully occupied. But his organizing talent made two great contributions to his country. One was the campaign against trachoma, he having been appointed to the position of state commissioner for trachoma. He worked out and caused the passing of legislative action on the subject. In connection with this campaign several ophthalmic hospitals were

erected throughout the country through his influence. The other great contribution was his activity in the fields of postgraduate instruction, which he organized with the financial support of the state. He started and edited a journal on postgraduate education.

He was active in organizing international medical congresses. In 1930, when visiting the United States at the invitation of the American Acad-



EMIL von GRÓSZ, M.D.
1865-1941

emy of Ophthalmology and Otolaryngology, he lectured at several places. On returning home from this trip he gave enthusiastic talks about the medical life and the hospitals of this country. The only pleasure other than his most active medical life he found in his family and in good music.

ANDREW DE ROETTH.

JOHN ROWLAND SHANNON, M.D.

1863-1942

John Rowland Shannon died in his seventy-ninth year at Richmond, Va., on July 4, 1942. Dr. Shannon was born in Kingston, Ontario, Canada, in 1863, attended the local schools and graduated in arts from Queen's University in 1885, winning the silver medal. He then entered the study of medicine, graduating in 1890 with the degree of Doctor of Medicine and Master of Surgery, and immediately proceeded to London, to do postgraduate work in ophthalmology. He worked at St. Thomas' Hospital and Moorfields Eye Hospital and later continued his postgraduate work in Vienna.

In 1892 he began the practice of ophthalmology in New York city, and he continued to practice until 1937, in which year he retired to Richmond, Va., where he continued to reside until his death. During the years 1892 to 1937 he was connected with the Manhattan Eye, Ear, and Throat Hospital, becoming successively assistant surgeon, surgeon and surgeon director; he also acted for some years as executive surgeon. During the first World War he was in the United States Army Medical Reserve Corps. He was a member of the American Medical Association, the American Ophthalmological Society and local medical societies.

He was descended from a family well known in the Dominion of Canada and the province of Ontario and long identified with the civic life of Kingston, Ontario. His father, James Shannon, was for years publisher of the local paper *The News* and when he retired was appointed postmaster of Kingston. He was a brother of Gen. Lewis W. Shannon, who later was appointed city clerk of Kingston and who still later was long identified with the military life of Kingston, becoming the officer in command of the Third Military District. Another brother, the late Robert W. Shannon, practiced law for some years in Kingston and then moved to the Canadian West, where he was legislative counsel for the province of Saskatchewan. Dr. Shannon when a student at Queen's was also in newspaper work. He was also an officer in the Fourteenth Battalion. He is survived by his widow, Caroline Shannon, of Richmond, Va., and by one brother, Alfred J. Shannon, of Kingston.

As an ophthalmologist, Dr. Shannon was an outstanding man of keen judgment and of marked operative ability. He brought a new

viewpoint to any problem presented and because of his wide experience his colleagues will miss his contribution to any discussion of a scientific subject. Personally he was a modest, kindly, genial and friendly man, a general favorite, and his former friends will learn with deep regret of his passing.

JAMES G. DWYER.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Injuries

INDUSTRIAL EYE INJURIES. A. MACNALTY, Brit. M. J. **1:** 173 (Feb.) 1942.

This investigation is important, as the amount of injury to vision caused by accidents is considerable and the economic loss to industry should not be ignored. The International Association for the Prevention of Blindness has an international classification of the causes of impaired eyesight and blindness under consideration which will be most valuable.

The author discusses the occupational diseases affecting eyesight under the following headings: the results of exposure to heat rays, miners' nystagmus and toxic effects of certain substances, such as lead, derivatives of benzene, carbon bisulfide and methyl alcohol. In the first group, glass workers' cataract is described as occurring in the form of a posterior cortical cataract. It is of slow onset and occurs only after fifteen to thirty years of glass working. When mature the cataract can be extracted with success. A committee of the Royal Society in 1908 decided that the evidence was in favor of the view that heat and not ultraviolet radiation is the active agent. It is uncertain whether the heat acts directly on the substance of the lens or indirectly by disturbing the nutrition of the lens. The question of wearing protecting glasses, which cause the wearer discomfort under working conditions, has brought about the opinion that prevention is better obtained through the machinery for the making of glass bottles which is now being adopted.

The symptoms from exposure to ultraviolet radiation are well characterized—pain, photophobia, conjunctivitis and headache—and can be prevented by screening of the lamps.

Workers in processes in which pitch is employed are liable to a form of ulceration. This injury can be prevented by wearing goggles.

Miners' nystagmus has been much studied in Great Britain, and the findings are contained in a number of accessible reports. The main conclusion was that the essential factor is deficiency in illumination. The recommendation was to increase the illuminating power so that the standard illumination is equal to that of an open pit light and to employ above ground men who suffer from this malady.

The question was reconsidered by a departmental committee of the Home Office on certain questions arising under the Workmen's Compensation Acts, and the report, published in 1938, is well worth reading.

The industrial poisons which affect the eyes have increased during the past twenty years, especially, as Resnick and Carris noted, in the United States from the enormous increase in the production of dyestuffs and other chemicals. The substances in England seem to be lead, derivatives of benzene, carbon bisulfide and methyl alcohol.

Occupations involving a risk of injuries to the eyes are considered as those occurring in factories, those occurring in mines and quarries and those occurring in agriculture and other occupations. The lesions produced by accidents are of all degrees of severity, ranging from transient conjunctivitis due to the entrance of a foreign body to complete destruction of the eyeball and loss of sight in one or both eyes.

The value of preventive medicine in industry is often not appreciated. Preventive measures should be regarded as a business proposition which aids industrial output and efficiency rather than as pure philanthropy. It is, of course, desirable that the entrants to industry be medically examined by a medical practitioner with ophthalmologic experience who can refer patients for expert ophthalmic advice if needed. The suggestions for handling the situation are excellent and well worthy of study in the original article.

The author concludes with the statement that it is encouraging to know that modern methods of prevention have greatly reduced the risk of ocular lesions from chemical and other processes and that the results of medical research and progress have been promptly applied. Cases of accidents to the eyes in mines, quarries and factories constitute by far the largest proportion of cases of impaired eyesight or of blindness among industrial workers. Their prevention is largely a question of periodic medical examination, of education and of the use of protective appliances and prompt ophthalmic treatment. Ophthalmic surgeons will find in industrial eye work not only a most interesting special branch of ophthalmology but an opportunity for investigation which will still further prevent impaired eyesight and blindness among industrial workers.

ARNOLD KNAPP.

Lens

OPERATION FOR CATARACT: CLOSURE OF THE WOUND; FREQUENCY OF COMPLICATIONS WITH DIFFERENT METHODS OF EXTRACTION. M. KLEIN, Brit. J. Ophth. **26**: 93 (March) 1942.

This review is based on 650 operations for cataract performed in the ophthalmic department of the Jewish Hospital of Budapest, Hungary, between 1933 and 1938. The article is lengthy. A detailed description of the technic employed is given. The author's comment and summary contain the salient points of the article and are here presented abridged.

"In the first part of this paper, statistical analysis of the whole mass of operations has shown that the method of wound closure has a significant influence upon the duration of the healing period. Experience with three different methods of wound closure—all widely used—has clearly proved that the shortest healing time follows the use of a corneo-scleral stitch. The difference in the time of healing between the conjunctival flap and Kuhnt's apron, and between Kuhnt's apron and the corneo-scleral stitch operations, is about 10 per cent. From this it can be seen that a considerable saving in nursing expense may be effected, and that the patient can return to normal life earlier.

"The corneo-scleral stitch is valuable where circumstances require rapid closing of the wound, as for example in cases of any complication during operation. Besides this the stitch gives protection against the

reopening or rupture of the wound, and should a wound rupture take place, the consequences are milder.

"In the second part of this paper an account is given of each individual case in which complication occurred during or after the extraction. Analysis has shown that:

"After vitreous complicated extractions the damage suffered by the eye was slight. This generalization, of course, is not valid in cases of excessive loss of vitreous.

"The incidence of prolapse of the iris and of the pillars of iris colobomata after extra-capsular extraction was about twice that following intra-capsular extraction. The treatment of prolapse of the iris should be immediate reparative operation, in which case the prognosis is relatively good. Subconjunctival iris prolapses, which develop weeks or months after the extraction are serious, and treatment consists in excision of the prolapse and adjoining scar tissue.

"Elevation of the pupil or of the pillars of colobomata or irregularity in the shape of the pupil, after vitreous complicated cataract extractions, causes no damage to the eye, while in those cases which occur after uncomplicated extractions, the pupil disorder was followed by increase of intra-ocular pressure in about half the cases.

"Among the serious cases of secondary glaucoma following extra- and intra-capsular extraction the ratio was five to one.

"In desperate cases of post-operative inflammation, the ratio in favor of intra-capsular extraction was eight to one.

"Secondary glaucoma and post-operative inflammation take the heaviest toll after cataract extraction, and the best means of avoiding them seems to be to employ intra-capsular extraction. . . .

"All the above considerations point to the value of reinforced wound closure by means of deep suture, and to the superiority of the intra-capsular method. Improvement in the technique of the intra-capsular extraction has made it applicable to all but a very limited number of cases, and full use should be made of it." W. ZENTMAYER.

CAUSES OF SENILE CATARACT. J. DE RUYTER, Ophthalmologica **102:** 93 (Aug.) 1941.

De Ruyter summarizes the causes of senile cataract and the results of physical, chemical and clinical investigations. He raises the question as to what causes death of the cells in the lenticular fibers. Increased knowledge of the life processes of the lens indicates that the causes are many. Senile cataract, the gradual decay of the cortical lenticular fibers which leaves a cell corpse behind, cannot be considered a disease entity. Death of the lenticular fibers can be caused by the aging process, by changed permeability and changed function of the lenticular epithelium or capsule (as elements of the lens aqueous barrier) and by defects in the blood vessels of the corpus ciliare, in the secretory function or in other elements of the blood-aqueous barrier. Electromagnetic oscillations may cause cataract. Defects which impair the composition of the blood, such as disturbances in the inter-retinal absorption of vitamins, disorders of the secretory glands (liver, thyroid and pancreas) and impairment of the regulatory mechanism for many blood constit-

uents may also be factors. There exist factors in aged persons which inhibit the carbohydrate intake of the lens: 1. The dextrose content of the aqueous humor is reduced. 2. The absorption of dextrose from the aqueous humor is impaired. 3. Hexose is not readily converted into hexose-diphosphoric acid and thus cannot be reached by decomposition ferments. 4. The permeability of the lenticular capsule is reduced. Thus the lenticular capsule is inadequately supplied with carbohydrates, a factor which may readily lead to cataract. Clinical manifestations of cataract have thrown little light on possible causes. Detection of metabolic defects which may cause cataract is difficult, because they may act only intermittently. It has been definitely established that hereditary predisposition plays a part in the pathogenesis. Rational treatment of a cataract is impossible as long as its cause is not understood, and for this reason the author stresses the necessity of classifying cases of senile cataract on an etiologic basis.

J. A. M. A. (ZENTMAYER).

Methods of Examination

DETACHMENT OF THE RETINA AND LIGHT SENSE PERIMETRY: REPORT OF CASES. M. AMSLER, Klin. Monatsbl. f. Augenh. **104:** 515 (May) 1940.

Examination of the field of vision in bright and in subdued light has not been practiced sufficiently. Stargardt devised the light sense perimeter in 1906, stressing the importance of this means of examination. Amsler uses with great success the Maggiore-Zeiss projection perimeter even in cases of detachment of the retina termed severe. He considers this apparatus indispensable for the evaluation of the pathologic condition in each case and of its treatment. The patient is placed in a semidarkened office for fifteen minutes to attain a medium stage between light and dark adaptation. The perimetric examination is twofold. The first phase is with a bright white projection target of 3 mm. and the second, directly afterward, with the same-sized target under one-sixteenth of the original brightness (filter no. 2). The boundaries of these two fields coincided in normal eyes and in dark-adapted eyes, whereas a maximal difference of about 10 degrees was noted in light-adapted eyes. Other targets up to the 5 mm. target and other filters, e. g. no. 3, of one-sixty-fourth the original brightness, may be used with similar results as long as the method of examination remains the same.

A detachment of the retina is clinically healed as soon as the operative scar is "water tight"; light sense perimetry will show this condition. The boundaries of the bright and the subdued light curves will deviate from one another whenever "a wet spot or bog" remains after apparent reattachment of the retina. The examination of the "water tightness" of the scar is of especial importance after operation for tears at the ora serrata; the ophthalmoscope is insufficient to evaluate the result of the operation.

Brief histories of 5 cases are given in illustration of Amsler's contention, together with the records of the fields of vision containing the

curves taken under bright and under subdued light and composite charts showing the same curves of thirty-two fields of vision. His fifth case, in the author's opinion, is especially fit to demonstrate the indispensability of this method in following up the course of treatment and in gaining valuable points for surgical decisions at the correct time.

K. L. STOLL.

Neurology

INTRACRANIAL CHORDOMA. H. ZEITLIN and S. A. LEVINSON, Arch. Neurol. & Psychiat. **45:** 984 (June) 1941.

A case of intracranial chordoma arising from the clivus Blumenbachii with anterior extension into the retro-orbital space, causing unilateral proptosis, is reported.

An ocular symptom first noticed about four months before operation was blurring of vision, especially on looking to the left. Then generalized headaches developed, and at about the same time the patient noted protrusion of the left eye and drooping of the left eyelid. Diplopia was frequently present on looking to the right. Glasses gave no relief of the difficulties in vision. At the time of admission to the hospital there was proptosis of the left eyeball associated with drooping of the left eyelid. Funduscopic examination showed primary atrophy of the left optic nerve and slight pallor of the disk in the right eye. Examination of the visual fields disclosed a right temporal constriction. The visual acuity of the right eye was 20/100 and of the left 2/200. Roentgenograms of the optic canal showed apparent destruction of the left side.

On cranial exploration the left optic nerve was found to be flattened by a bluish tumor mass which lay underneath the nerve. Because of the size and the location of the tumor only a small piece of tumor tissue was removed for microscopic study.

The gross and the microscopic examination of the brain are reported in detail. The author concludes that the histologic features of the chordoma partially reduplicate the morphologic features of the chorda dorsalis during its stages of evolution and that malignant infiltrating chordomas at the base of the brain have a tendency to include large blood vessels, thereby making surgical removal difficult, whereas small, encapsulated noninvasive chordomas might be eradicated by excision.

R. IRVINE.

LINDAU-VON HIPPEL DISEASE: A REPORT OF FOUR CASES. W. McK. CRAIG, H. P. WAGENER and J. W. KERNOHAN, Arch. Neurol. & Psychiat. **46:** 36 (July) 1941.

From the ophthalmoscopic standpoint, the 4 cases reported represent four distinct phases of the disease. "In 1 case the onset and development of the retinal lesion were very atypical. In another the lesion was confined to one eye, and papilledema was not present. In the 2 remaining cases angiomas were present in both retinas. In 1 instance, however, the angioma in one eye was very small and had not developed fully into a large tumor. It had undergone almost complete gliosis. In the last case the angioma in the second eye had resulted in detachment of the retina and formation of a secondary cataract; papilledema was also present. . . .

"Clinically, all 4 cases were interesting. Case 1 presents an excellent example of an early manifestation of the retinal angioma which in its more chronic phase may be confused with other types of lesions of the retina; in this instance it simulated tuberculous choroidoretinitis with periphlebitis. Only with the development of cerebellar symptoms and intracranial hypertension was the retinal lesion suspected of being von Hippel's disease. The second and third cases, although differing in some respects, were more or less classic as regards the development and the diagnosis of the disease. The fourth case, again, presents a somewhat different clinical picture, which is explained by the observations at operation and necropsy. The surgical procedure employed in the 3 cases is more or less standardized, consisting in drainage of the cystic cavities, removal of the tumor nodule and removal of the wall of the cyst. The postoperative results were excellent, and the functional recovery was remarkable. In view of so many pathologic lesions in case 4 it is evident that any form of treatment was doomed to failure."

The article includes a worthwhile review and discussion of the literature on Lindau-von Hippel disease as well as the excellent and detailed report of these 4 cases.

R. IRVINE.

MARCUS GUNN PHENOMENON. F. D. INGRAHAM and J. B. CAMPBELL, Arch. Neurol. & Psychiat. **46:** 127 (July) 1941.

Three cases of the Marcus Gunn phenomenon, so-called jaw winking, are reported, the third case being an instance of the phenomenon in a patient with jacksonian epilepsy. In the course of an exploration of the right parietal cortex for excision of a trigger area, jaw winking was elicited by cortical stimulation. The authors believe this to be the first recorded instance in which the Marcus Gunn phenomenon was thus elicited.

R. IRVINE.

PATTERNS OF CEREBRAL INTEGRATION INDICATED BY THE SCOTOMAS OF MIGRAINE. K. S. LASHLEY, Arch. Neurol. & Psychiat. **46:** 331 (Aug.) 1941.

Every detail of this article should be of interest to ophthalmologists. In fact, the article might well be republished in an ophthalmologic journal.

The maps of scotomas during migraine attacks and the author's interpretation of them are important for an understanding of the relation of the visual field to the region of the cortical area excited.

Lashley reports two characteristics of the scotomas not previously reported: (1) the maintenance of the characteristic shape of the scotoma during its drift across the visual field and (2) the "completion of figure."

He summarizes his investigation as follows:

"Maps of the scotomas of ophthalmic migraine sketched at brief intervals during an attack suggest that a wave of intense excitation is propagated at a rate of about 3 mm. per minute across the visual cortex. This wave is followed by complete inhibition of activity, with recovery progressing at the same rate. Sometimes the inhibition spreads without the preceding excitatory wave. Limitation of the disturbance to the

primary visual cortex raises questions as to the nature of the interconnections between architectonic fields. The observations are interpreted in relation to the possible integrative effects of radiating waves of excitation in the cortex."

R. IRVINE.

Ocular Muscles

DARK ADAPTATION AND MINERS' NYSTAGMUS. I. CAMPBELL, Brit. M. J. **2:** 726 (Nov. 22) 1941.

The association between failure of dark adaptation, or night blindness, and miners' nystagmus has long been recognized. It has also been known that hemeralopia is found in the prenystagmus stage of miners' nystagmus. As for an association of diet with miners' nystagmus, an improvement in housing conditions led to a supply of vitamin A from green vegetables and carrots in the summer months, while in the winter months this was necessarily greatly reduced, and of course the winter is the time in which the intake of vitamin A is at its lowest and the demand for it in the interest of vision is at its highest. A study of a number of tables has shown that most failures occur in the first quarter of the year. The chief factor in miners' nystagmus is now generally recognized as deficient illumination. A number of miners were examined with Crookes's dark adaptation tester, which showed that a deficiency of vitamin A, as demonstrable by the dark adaptation test, was present, and by the administration of vitamin A over a limited period the power of dark adaptation was considerably improved. As the miner depends for his working vision, and safety, on his retinal periphery and must continually adapt to low illumination and sudden changes in light intensity, it seemed desirable that he should receive an optimum supply of vitamin A.

ARNOLD KNAPP.

ERRORS IN THE STEERING OF PLANES AND AUTOMOBILES CAUSED BY OCULAR MOVEMENTS. G. MARTIN, Arch. f. Ophth. **142:** 262, 1940.

The controls of a plane were imitated by a relatively simple laboratory setup. Lateral ocular movements had a measurable effect on the accuracy with which the examinee performed certain steering tasks.

P. C. KRONFELD.

Orbit, Eyeball and Accessory Sinuses

ORBITAL CELLULITIS FROM GAS-PRODUCING ORGANISMS. I. S. MCGREGOR, Brit. M. J. **1:** 292 (Feb. 28) 1942.

A man 68 years of age complained of pain in his right eye for five days, and the lids were much swollen. Small incisions were made through the skin of both eyelids close to the upper and lower orbital margins. Brown pus and bubbles of gas escaped from the wounds. The smell was extremely foul. The proptosed eyeball was immobile, and folds of conjunctiva hung over the cornea. The right antrum and right ethmoid sinus were also found involved. The patient was given

anti-gas-gangrene serum and sulfathiazole (2-[paraaminobenzenesulfonamido]-thiazole) both intravenously and intramuscularly. After four days of improvement his temperature, which had been 101 F., dropped to normal. The swelling of the lids subsided slowly, and the proptosis receded. When it was possible to examine the eyeground the optic nerve was seen to be atrophic. The bacteriologic examination showed various cocci and a few bacilli with filamentous forms. The eye was completely blind. The left eye was normal.

The author speaks of the rarity of gas bacillus infection of the orbit. He does not believe that the orbital inflammation included gangrene of the muscle. The difficulties of the excision of affected muscles in the orbit is discussed. According to the author the cause of the optic nerve atrophy is obscure, but he thinks that the findings can be reasonably explained by an exudative perineuritis or neuritis with early thrombosis of the nutrient vessels of the optic nerve. ARNOLD KNAPP.

Refraction and Accommodation

THE RELATIONSHIP BETWEEN MYOPIA AND AVITAMINOSIS. J. LAVAL, Am. J. Ophth. **24:** 408 (April) 1941.

Laval draws the following conclusions:

"1. There is experimental proof that A avitaminosis will cause changes in the ocular tissues of experimental animals primarily in the cornea and sclera.

"2. There is insufficient proof that D avitaminosis alone will cause changes in the cornea and sclera.

"3. Infants and children in New York City get sufficient amounts of vitamins A and D, and this is true of those children coming from poor homes as well as from the well to do.

"4. Excessive dosage of viosterol has caused unhappy results in children, and excessive dosage of viosterol in adults may be carcinogenic in effect.

"5. Myopic persons should not constantly wear their correction for myopia for distance vision unless vision without the glasses is so poor that the wearing of glasses is absolutely necessary. But the myopic must wear their correction for close work always." W. S. REESE.

THE SIGNIFICANCE OF STURM'S INTERVAL IN REFRACTION. A. DEH. PRANGEN, Am. J. Ophth. **24:** 413 (April) 1941.

Prangen discusses Sturm's interval and reports 5 pertinent cases. He gives the following summary and conclusions:

"The phenomena incident to and illustrated by Sturm's astigmatic interval have a broad and varied clinical application to the problems of astigmatism in refraction. By visualizing or keeping in mind these phenomena of Sturm, the ophthalmologist is aided in his work. Such visualization makes refraction a much more vital procedure and a much less routinely mechanical process. The employment of equivalently reduced formulas is most useful for astigmatic eyes, concerning which

difficulty is anticipated in the patient's wearing fully correcting cylinders. Partial correction of astigmatism is advocated only for such selected eyes as those in which the adaptation to full correction is likely to be difficult."

W. S. REESE.

Retina and Optic Nerve

CHANGES IN RETINAL ARTERIES BEFORE CONVULSIONS INDUCED BY ELECTRIC SHOCK. E. C. MILCH, Arch. Neurol. & Psychiat. **45:** 848 (May) 1941.

During the course of the electric shock treatment of psychoses at the New York State Psychiatric Institute and Hospital the author examined the retinal arteries before and after the electric shocks were administered. The state of the retinal arteries was of interest to him as an index of the state of the cerebral vessels. The method employed and the evaluation of the observations made are presented. The observations are summarized as follows:

"The electric shock per se has no prolonged effect on the artery, and any immediate effect is one of dilatation, as indicated by the 2 observations made in three to four seconds after the passage of the current.

"In all cases in which a sufficiently prolonged period of unconsciousness precedes the active convulsive state the retinal arteries constrict prior to the onset of the convulsion.

"In the majority of cases in which no retinal constriction occurs during the period of 'absence' no convulsion occurs. Three observations out of 13 tended to refute this as a general rule.

"From the preceding observations, one may conclude that in cases of convulsions following electric shock a spasm of the retinal arteries, during the 'absence,' usually precedes the generalized convulsion and that as a rule a spasm does not occur if the effect of the shock is to give only a 'petit mal' seizure or an 'absent' state. In addition, if one can infer that the appearance of the retinal artery accurately reflects the condition of the smaller cerebral arteries, one may conclude that the arterial spasm does not cause the convulsion but is itself an early part of the process sent into action by something else, in this case the electric shock."

R. IRVINE.

CHORIO-RETINITIS JUXTA-PAPILLARIS (E. JENSEN). R. G. POSTHUMUS, Brit. J. Ophth. **26:** 23 (Jan.) 1942.

Posthumus gives a critical résumé of the literature and reports several cases of retinochoroiditis juxtapapillaris. He give the following summary:

The syndrome is of infrequent occurrence or at least is not often diagnosed. It is characterized by an inclination to recur; the lesion is situated around and near the retinal vessels, mostly in juxtaposition or close to the papilla; sometimes it is attended by slight hemorrhages along the retinal vessels, which both in the recent exudate and in the cicatrix are contracted and indented. The condition occurs most frequently in men, usually in the second or third decade. The etiologic factor is not known with certainty but may be variable. Primarily the

lesion is situated in the innermost layers of the retina. When newly acquired it consists of a focus projecting into the vitreous humor to an elevation up to 2.5 mm. or more. The vitreous may contain strings of exudate and may be turbid. These changes may be due in part to cyclitis or iridocyclitis if present. From the primary site the focus also extends outward into the deeper layers of the retina and the choroid. Characteristic is the sector, arch or paramacular limitation of the visual field produced by destruction of neurofibrils. The prognosis is favorable.

The author hesitates to suggest still another name for this lesion but believes "retinitis interna circumscripta" appropriate.

The article is illustrated.

W. ZENTMAYER.

THE SIGNIFICANCE OF A LESION OF THE OPTIC NERVE. G. J. DIXON, Brit. J. Ophth. **26:** 64 (Feb.) 1942.

The author reviewed a series of cases of optic nerve lesions to determine in what proportion a clinical diagnosis could be made with certainty and then observed both diagnosed and undiagnosed cases for a number of years to see how far in the first group the prognosis was fulfilled and in what proportion in the second the diagnosis was revealed.

"Here described are five cases where an optic nerve lesion appeared in the absence of any obvious cause and where observation for a period of ten years failed to reveal any further pathology. Although these cases have been extensively investigated, no evidence of other disease, either in the nervous system or elsewhere, has been found to account for the lesions. That such cases are relatively frequent may be judged from the fact that four of them occurred in a consecutive series of twenty-four cases of optic nerve lesion which had been discovered when the patient sought advice for a failure or abnormality of vision. In the same series there were six frank cases of disseminated sclerosis and five of tabetic optic atrophy, while only one doubtful case developed disseminated sclerosis during the period of survey. Unfortunately, eleven patients of this series were lost after periods shorter than one year, and before any cause could be established for the optic nerve lesion."

W. ZENTMAYER.

Uvea

HARADA'S DISEASE. A. MAGITOT and A. DUBOIS-POULSEN, Ann. d'ocul. **177:** 145 (April) 1940.

Harada's disease is a symptom complex the essential signs of which are bilateral uveitis with signs of detachment of the retina, general and neurologic phenomena, modifications in the distribution of hair and, finally, vitiligo.

It has been observed mostly in the Orient, and in 1923 Harada, who first grouped the symptoms, published a complete clinical study of 10 cases.

The authors give the early history of the disease and describe in detail 3 cases in which they believe the condition corresponded exactly to Harada's disease. In the first case the general and the meningeal phenomena were severe. Both tuberculosis and syphilis were excluded.

In 2 cases there was double uveitis with choroidal detachment (rather than retinal), and in 1 of these there was deafness. Vitiligo was observed only in the third case.

The disease seems to be due to a virus which strikes at the same time the meninges, the eye and sometimes the ear. The pathologic process remains obscure. Experiments by Japanese workers tend to prove that it is due to a neurotropic virus; other investigators think it is of tuberculous origin. The problem is not simplified by the fact that there exist different forms of the disease. The article contains a bibliography.

S. H. McKee.

Stray Illumination of the Ciliary Body Caused by Diffraction in the Crystalline Lens. J. A. van Heuven, Arch. f. Ophth. **142:** 319, 1940.

The phenomenon of stray illumination of the interior of the eye by light rays which undergo diffraction in the lens is generally known. Van Heuven, with the aid of the physicist Z. van Zelst, apparently has been the first ophthalmologist who has ever tried to measure the amount of diffracted light that falls on the ciliary body. One eye of a rabbit under the influence of ethyl carbamate (urethane) was dislocated in front of the lids. By careful dissection the ciliary body was first exposed and then removed over an area of 1 sq. cm. With reasonable care loss of vitreous could be avoided. From a standardized light source light was thrown into the eye along its optical axis. A spectrophotometer was placed opposite the hole in the ciliary body. Thus objective measurements of the stray light falling onto the ciliary body could be made. Under the conditions of a bright summer day the author estimates that enough stray light strikes the ciliary body "to enable an imaginary dwarf sitting on the ciliary epithelium to read his newspaper in comfort."

The second part of the paper deals with the question whether or not this stray illumination is injurious to the ciliary body. The author applied Friedenwald's intraocular gas bubble technic (Arch. Ophth. **17:** 477, 1937), the principle of which is to introduce gas bubbles of known composition (usually pure nitrogen) into the chambers of the eye and to aspirate and analyze them after certain intervals. With this method Friedenwald found that the ciliary body secretes oxygen into the eye. Air bubbles which had been lying next to the normal ciliary body for several hours were on aspiration found to contain 26 per cent oxygen, whereas bubbles that had been in the anterior chamber contained only 18 per cent oxygen. Air bubbles introduced into eyes the ciliary body of which had been exposed to a stray illumination of from 4 to 10 lux for two hours contained only 11 per cent oxygen if they had been in the posterior chamber and 8.4 per cent oxygen if they had been in the anterior chamber. Severing of the optic nerve had no effect on the results of such experiments.

"Now we know that the lens diffracts incident light and that this diffracted light strikes the ciliary body and has injurious effects on it if too intense. The oxygen supply to the lens becomes poorer, which in turn entails opacities of the lens, which in turn intensify the scattering of light by the lens. Thus a true vicious circle is established."

P. C. Kronfeld.

Vision

"Perfect Sight Without Glasses." A. S. Phillips, Brit. M. J. **2:** 703 (Nov. 15) 1941.

The author draws attention to the current appearance of the popular phrase "perfect sight without glasses" combined with a recommendation that two books on the subject, in which it is stated that perfect sight can be achieved by exercises and without the aid of glasses, be read. He goes on to state that neither of these books can be taken seriously and that there is little truth or sense in either. He then explains what can be accomplished by exercises.

There are no exercises which will replace glasses genuinely needed, but exercises can do a great deal for certain muscular anomalies, such as convergence insufficiency, which is not at all uncommon.

A lack of stereoscopic vision is frequently noted when a pilot learning to fly is unable to land an aircraft with safety although his visual acuity is normal. Exercises will make many such men first class pilots. This fact was proved in England by the work, in particular, of Group Captain Livingston and Group Captain Clements, whose studies of heterophoria as it concerns flying are well known. It must, however, not be forgotten that any one who has lost an eye while young and has had time to readjust himself will make a perfectly safe civil pilot if the other eye is sound but that on account of the restricted field he would obviously be unsafe as a service pilot.

Arnold Knapp.

Visual Tracts and Fields

Incomplete Homonymous Hemianopia with Tumor of the Posterior Cranial Fossa. A. Natale and G. H. Dickmann, Arch. de oftal. de Buenos Aires **15:** 343 (July) 1940.

After reference to the usual visual field defects associated with chiasmatic and parachiasmatic lesions, the authors call attention to the fact that lesions at some distance from the chiasma may produce similar detects, a fact recognized by ophthalmologists and neurosurgeons. They report a case in which a tumor of the posterior fossa projected into the fourth ventricle and by dilation of the third ventricle pushed the chiasma downward, compressing it against the veins forming the polygon of Willis, with the production of bitemporal hemianopia. The diagnosis in this case was made by ventriculography and confirmed at operation.

C. E. Finlay.

Society Transactions

EDITED BY DR. W. L. BENEDICT

COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OPHTHALMOLOGY

ALFRED COWAN, M.D., *Chairman*

WARREN S. REESE, M.D., *Secretary*

February 19, 1942

Penetration of Sulfathiazole into the Eye: Further Studies. DR. H. G. SCHEIE and DR. I. H. LEOPOLD.

This article was published in full in the May issue of the ARCHIVES, page 997.

DISCUSSION

DR. F. H. ADLER: The results of these experiments are clear and convincing. They have a value which is beyond their immediate significance, because they point out factors which must be taken into account when one evaluates the effect of drugs in the eyes. They show an effect that one cannot always deduce: the action of a drug in a diseased eye as compared with its effect in a normal eye. As Dr. Scheie has pointed out, in an eye which is infected the blood-aqueous barrier is altered and permeability is much greater than in the normal eye. As a result, certain drugs which fail to pass through the barrier of the normal eye will penetrate the inflamed eye.

I should like to say a word about the microcrystalline form of sulfanilamide and its derivatives. Last year Dr. B. F. Souders was interested in obtaining some of these drugs which could be injected by hypodermic needle. The ordinary crystals are too large to go through the bore of a hypodermic needle. The biochemists in the Johnson Foundation succeeded in obtaining the drugs in microcrystalline form. The importance of this fact was immediately realized by members of other departments in the hospital, and as a result extensive research was begun with the aid of a grant from the Smith, Kline & French Laboratories under the direction of Dr. Joseph Stokes, professor of pediatrics at the University of Pennsylvania School of Medicine. The microcrystalline form of the drugs is now being investigated by various members of the department.

As a result of these experiments by Dr. Scheie and Dr. Leopold, it is known that one may use the ordinary form of the drugs by injecting them into the blood stream. If it is advisable to inject the drug directly into the vitreous or the aqueous, the microcrystalline form may be used.

Temporary Abducens Nerve Paralysis not Associated with Other General or Neurologic Abnormalities. DR. W. I. LILLIE.

Eight cases were reported of temporary paralysis of the abducens nerve in which there was no evidence of associated general or neurologic disease. The paralysis resulted apparently from undue exposure of the patients while driving or riding in an automobile. Seven patients were men in whom paralysis of the left abducens nerve developed while they were driving with the car window partially or completely open. The eighth patient, a woman, was a passenger in the front seat. A general and a neurologic examination, including analysis of the spinal fluid and roentgenograms, was made in all 8 cases. The physical and the neurologic status of the patients were normal except for paralysis of the abducens nerve. The ages of the patients ranged from 42 to 68 years. The interval between the time of exposure and the appearance of the diplopia varied from two to ten days. The duration of the diplopia varied from three weeks to six months.

The end result in all 8 cases was complete restoration of function and disappearance of diplopia. The therapy employed was purely empiric.

DISCUSSION

DR. G. G. GIBSON: Dr. Lillie has presented a new cause of a well known clinical entity, abducens nerve palsy. This new cause is exposure of the patient to a draft while riding in an automobile with the window open.

Dr. Lillie's paper is of special interest to me because it has been my privilege to see 2 of the patients whose cases he reported. As I have examined them and listened to their stories, I am readily convinced of the accuracy of Dr. Lillie's conclusions and of the diagnosis he has made. Necessarily, in this type of case one has to make the diagnosis by exclusion, and those who require 100 per cent proof of the exact mechanism of the condition will find something wanting in Dr. Lillie's interpretation, because there is no way in which the correctness of the assumption can be proved. However, Dr. Lillie has, by exclusion, arrived at the best possible explanation for this type of condition, and his explanation makes it possible for one to concur in the conclusions he has reached.

It is of interest to note that he compares this inflammatory lesion of the abducens nerve to Bell's palsy, which is an inflammatory condition of the facial nerve. It is extremely difficult to exclude such rare conditions as a possible hemorrhage into the nerve due to exposure. Dr. Lillie did not expressly mention that he had excluded multiple sclerosis as a cause of the condition, but I am sure that he had done so, because he has repeatedly explained to me the importance of excluding multiple sclerosis in similar cases. I wish he had said that the patients were not in the proper age group or had not the natural tendency toward multiple sclerosis. These facts, combined with the fact that the spinal fluid was normal, would rule out the possibility of multiple sclerosis.

It is rather difficult to understand how the sixth nerve, which is so well protected both in the depths of the cranium and in the depths of the orbit as compared with the relatively exposed facial nerve, could be affected by exposure. I should like therefore to ask Dr. Lillie what

his conception is of the actual disturbing mechanism. I should like to know whether he considers the paralysis due purely to exposure or conceives it as a decrease in local resistance of the nerve resulting in a secondary inflammatory lesion. I wonder if it would be possible for this condition to occur bilaterally if both abducens nerves were subjected to exposure.

It is interesting to note that Dr. Lillie's experience with this type of ocular neuritis due to exposure began in 1934, shortly after he left Minnesota and came to Philadelphia. I wonder if this is purely a coincidence or if there is some difference in the climatic conditions or in the resistance of the people here as compared with those in Minnesota. I do not say this facetiously, because I know that there is a marked difference between the types of cases encountered in the practice of ophthalmology in Minnesota and those encountered in Pennsylvania. An example is the relative incidence of pterygium in Minnesota and in Philadelphia, which Dr. Lillie mentioned in his lectures to the senior students. Ophthalmologists in Minnesota claim that the incidence of pterygium is high there owing to climatic conditions. In Philadelphia, that is not true.

I have observed a case recently which, if not exactly the same as those reported by Dr. Lillie, was comparable to them at least. In this case it was necessary to make a differential diagnosis including the syndrome which Dr. Lillie has described. The patient was a man 60 years old who had experienced a sudden onset of diplopia. The characteristic picture of sixth nerve palsy was evident. On questioning the patient closely, I learned that he was employed as cashier in a restaurant and that, stationed near a revolving door, he had been exposed three days before the onset of his palsy to a severe draft during a recent spell of cold weather. However, on close questioning as to the patient's history I learned that he previously had suffered from sixth nerve palsy, and I came to the conclusion that the condition then present was merely an exaggeration of a condition which had previously existed. It probably is not fair to include this case in the same category as the cases which Dr. Lillie has reported, although it might well be considered similar. The diplopia cleared up in three weeks without any treatment. However, a complete work-up such as Dr. Lillie accomplished was not carried out.

DR. H. M. LANGDON: I am puzzled by two things in Dr. Lillie's paper. First, I should like him to define what he means by "temporary." Second, what is the actual cause of paralysis of the sixth nerve?

I recall the case of a man who consulted Dr. S. Weir Mitchell and gave a history of long-standing paralysis of the right external rectus muscle. Dr. Mitchell could find no cause for the condition in the patient's history, in the physical examination or in the general neurologic examination. Dr. George de Schweinitz was asked to see the patient, and he evidently was as puzzled as Dr. Mitchell, but he did not say so in so many words. He stated all the possible causes and suggested among other possibilities that the condition might be one of the transient palsies of Mauthner. So what is meant by "temporary" and "transient"?

I can recall 4 patients who suffered from palsy of an ocular muscle. In 2 the external rectus muscle on one side was affected, in 1 both external rectus muscles were affected and in 1 the superior oblique

muscle was involved. In all cases the cause could not be determined, for no other neurologic signs were present and recovery was complete in a short time.

One of the patients was a woman 25 years old who for several days had had diplopia when looking to the right. She could not recall just when the symptoms began, but evidently they had developed three days or a week previously. Her vision was 5/4, with the near point suitable for her age. The left pupil was slightly larger than the right, but it reacted well to light and accommodation. The ocular rotations were full, except for the outer rotation of the right eye. The diplopia present was typical of paralysis of the right external rectus muscle. There were no changes in the fundus. The Wassermann reaction of the blood was negative, the spinal fluid was normal and the knee jerks were normal. Dr. Francis Sinkler made a neurologic examination. Esophoria of 40 degrees, as measured with the Maddox rod, was present when he first saw the patient, on September 19. By April 22 of the following year examination revealed that esophoria of only 3 degrees was present, the rotations of the eyes were full and there was no evidence of diplopia.

The second patient, a man 37 years old, gave a history of diplopia of three weeks' duration, which was evident one morning when he awoke. Examination in June 1938 revealed that the vision was normal in each eye, there were no pupillary changes and the neurologic signs were normal except for an absence of knee jerks, which was not pathognomonic. The patient was also examined by a competent neurologist. The Wassermann reaction of the blood was negative, and the spinal fluid was normal. Ophthalmic examination revealed esophoria of 3 degrees for distance, but left hyperphoria of 10 degrees, and diplopia typical of involvement of the left superior oblique muscle. By January 1939 the diplopia had entirely disappeared, and there was orthophoria at 5 meters.

The third patient, a woman 56 years old, for whom I had performed refraction several times during the preceding ten years, gave a history of diplopia associated with some nausea. Ophthalmic examination on Feb. 27, 1932 revealed the corrected vision to be 5/5 in each eye, with the near point suitable for the age. The muscle balance, measured with the Maddox rod, showed 20 degrees of esotropia. Previous to this examination the esotropia had never measured more than 1 or 2 degrees. The diplopia over the entire field suggested paresis of the right external rectus muscle. The neurologic examination did not reveal signs of disease of the central nervous system. The Wassermann reaction of the blood was negative. The patient would not submit to a spinal puncture. She stated that thirty years before she had had a similar attack, at which time she had been seen by Dr. S. D. Risley, who advised surgical intervention. Her present condition gradually improved, and by June 1932 there was no evidence of diplopia. She had no further distress.

In the fourth case there was evidence of paralysis of the external rectus muscle of each eye and also a loss of inward rotation of each eye, with no loss of upward or downward rotation. I considered these conditions to be due to encephalitis. The patient's vision was normal. At the time of her first visit she did not complain of diplopia, and examination of the muscle balance disclosed 1 degree of esophoria. The

following day, however, the patient experienced definite diplopia on looking to the right, and within a week there were complete loss of outward rotation in each eye and definite diminution of inward rotation. Upward and downward rotations were normal. The patient would not submit to a neurologic examination. A careful physical examination was carried out, however, which included some neurologic tests. The Wassermann reaction of the blood was negative. A spinal puncture was done. Rest and the use of iodides were prescribed. Two months from the time the symptoms appeared, the patient's condition was normal, and she was no longer troubled by diplopia. The ocular rotations were full; 1 degree of exophoria was present at 5 meters and 4 degrees at reading distance. There was no recurrence of the symptoms. I concluded that this was a case of encephalitis.

I have reported these cases to show that paralysis of the external rectus muscle does not always result from riding in motorcars.

DR. W. E. FRY: As I understand it, most of the patients suffering from this type of distress recover rather early, within six weeks. However, 1 or more of Dr. Lillie's patients did not recover completely until six months had elapsed. I wonder if Dr. Lillie can recall how soon recovery begins to appear in such cases.

DR. S. BRAV: Dr. Langdon stated that the Wassermann reaction of the blood was negative in the cases he reported, but he did not say anything about the level of sugar in the blood. In my experience, in many cases paralysis of the external rectus muscle is due to changes in the level of the sugar in the blood.

DR. H. M. LANGDON: Chemical analysis of the blood was done in all the cases, and the level of sugar in the blood, that of urea in the blood, and so forth, were normal.

DR. M. BUCHANAN: Does the humidity in Minnesota differ from that in Philadelphia?

DR. W. I. LILLIE: I am pleased that my presentation has aroused so much discussion. The cases reported by Dr. Langdon do not fall into the same group as those that I have reported, because apparently no direct causal factor could be ascertained from the histories of the patients. Just what is the actual cause of sixth nerve paralysis in cases such as those he presented is not known, although it is safe to postulate that the basic pathologic process must be either an inflammatory or a vascular condition.

In answer to Dr. Gibson's questions, sixth nerve paralysis is known to be caused by many different etiologic factors, which can be determined by general or neurologic examination. Such factors can be ruled out as far as my report is concerned, because the general and the neurologic examinations in each case revealed normal findings.

In answer to Dr. Buchanan's question concerning the relative difference between the humidity of Minnesota and that of Pennsylvania, I am sure that the weather in Philadelphia is much more humid, but I do not believe that humidity is a factor to be considered in sixth nerve paralysis.

A few years ago Dr. J. C. Yaskin, of Philadelphia, presented a paper dealing with paralysis of the ocular rotation in which a group of patients suffering from sixth nerve paralysis was mentioned, but in this group

there was no direct relationship to exposure, although he did mention "exposure" as a possible cause. I believe that Dr. Yaskin's cases are closely related to mine, although he did not mention the direct relationship of sixth nerve paralysis to riding in an automobile.

In answer to Dr. Fry's question concerning the length of time the paralysis persists, I might say that in my series of cases the longest interval before improvement was obtained was four to six months.

Cicatricial Lagophthalmos. Dr. E. B. Spaeth.

From the surgical standpoint, causes for lagophthalmos can be classified as follows: (1) loss of soft tissue following a malignant process or trauma of the upper lid, (2) paralysis of the orbicularis oculi muscle, (3) a cicatrix and (4) a high degree of exophthamos. Consideration of the surgical procedure necessary in treating lagophthalmos should be based on this classification of causes.

(Dr. Spaeth had previously shown before this society films which illustrated the second and third causes. The film depicting the fourth cause is still in preparation.) A film was shown which illustrated lagophthalmos from the first cause. It depicted a case in which lagophthalmos had developed as a result of loss of tissue and one in which lagophthalmos had developed after malignant lesions had been removed from the forehead and temporal region. In the first case the loss of tissue resulted from trauma produced by several lacerations which extended through the upper lid. Because of the lacerations and also because of a high degree of ectropion, a free skin graft could not be used. A pedicle flap was thought necessary. In the second case lagophthalmos developed as a result of contracture following radium treatment to malignant lesions of the forehead and temporal region. The malignant process had not been present in the lid itself.

Alfred Cowan, M.D., *Chairman*

Warren S. Reese, M.D., *Secretary*

March 19, 1942

Ocular Phenomena Elicited by Withdrawal of Aqueous Humor in Man. Dr. P. C. Kronfeld, Chicago (by invitation).

A Dutch physician by the name of Anton Nuck, professor of medicine at the University of Leyden, in a publication dealing with ophthalmologic matters which appeared in print in 1690 was the first author to record the fact that the aqueous humor in man rapidly regenerates after paracentesis. Not until about thirty years ago did it become known that withdrawal of the aqueous humor represents a stimulus for a number of reactive processes within the eye. Wessely, Seidel, Kahn and Loewenstein, Bonnefon, Magitot and Hagen are the chief contributors to the subject.

This report deals largely with the mechanical aspects of the reactive processes set up by withdrawal of the aqueous humor. (In the com-

plete report the technic of puncture of the anterior chamber is described in detail.) In well over one thousand punctures which my associates and I have performed during the last fourteen years, injury to the lens has occurred only three times. In each of these instances the technic was faulty. I do not recall any case in which an ocular infection or even mild iritis developed as a result of the puncture. I firmly believe, however, that there are situations in which withdrawal of the aqueous humor is contraindicated.

The amount of fluid that can be aspirated from a given eye is definitely limited and fairly constant. The term "complete" has been applied to punctures of the anterior chamber in which the aspiration has been continued until the portion of the iris lying next to the tip of the needle begins to be sucked into its lumen. At this time traces of fluid may still be present in other parts of the anterior chamber, but I have never tried to collect this fluid by moving the tip of the syringe to other parts of the chamber. I consider it unlikely that part of the fluid obtained by this technic is derived from the posterior chamber. The amounts of fluid obtained by aspiration closely parallel the depth of the chamber as determined by photographic methods such as Friedenwald's and Goldmann's. Slit lamp examination immediately after "complete" puncture reveals either contact of the iris with the posterior surface of the cornea or the presence of an extremely narrow space between the two surfaces.

My associates and I have studied the rapidity with which intraocular fluid regenerates. In eyes with an average chamber depth, 50 per cent of the original chamber fluid is found to have regenerated ten minutes after complete puncture. Thirty minutes after puncture, 75 to 80 per cent of the original chamber contents may be recovered. The rapidity with which fluid regenerates is slightly greater in eyes with naturally deep chambers. The difference in the rate of regeneration is, however, not great enough to make up for the difference in the original chamber volume. Thus the restoration of the original volume of fluid within the chamber takes longer in eyes with naturally deep chambers.

Bonnefon has proposed distinguishing the four phases of intraocular pressure after puncture of the anterior chamber as state of collapse, state of recuperation, state of hypertonicity and state of return to normal tonicity. For the study of fluctuations in ocular tension after such puncture in man, my associates and I have found that the following terms are more convenient: (1) the initial drop; (2) the restoration time, that is, the time required for the tonometric reading to reach the original level; (3) the hypertensive phase, and (4) the hypotensive phase.

The restoration time is dependent on the original chamber volume, that of eyes with deep chambers being definitely longer than that of eyes with shallow chambers. During the restoration time the amount of fluid that regenerates closely parallels the intraocular pressure. Thus the restoration time is largely dependent on and chiefly represents the reformation of intraocular fluid, or, to use Friedenwald's terminology, the transfer of fluid into the eye under the conditions prevailing after puncture of the anterior chamber.

Of the various reactive processes set up by such puncture, the occurrence of ocular hypertension is the most conspicuous one and has

attracted the attention of a great many ophthalmologists. Seidel first reported its occurrence in dogs and cats after the anterior chamber had been partially emptied, and he interpreted it as due to hypersecretion of aqueous, the puncture of the anterior chamber representing a strong stimulus for the ciliary body. Magitot has stressed the similarity between the hypertensive reactions following puncture and those following compression of the globe.

During the last fourteen years my associates and I have studied the hypertensive phase after puncture of the anterior chamber on a large number of nonglaucomatous human eyes. For the obvious reason that only a limited number of human eyes could be subjected to puncture, the progress of the work has been slow, but now we believe that we have a fairly complete knowledge concerning the extent and the duration of the hypertensive phase in nonglaucomatous eyes. The hypertensive reactions in glaucomatous as well as in nonglaucomatous eyes are self limited and subside within four hours after puncture. In a group of white and Negro patients with nonglaucomatous eyes at the Illinois Eye and Ear Infirmary, the highest tension reached after puncture was 42 mm. of mercury (Schiøtz). Because of the inaccuracy of all tonometric readings, even tensions as high as 45 seem possible in nonglaucomatous eyes. A tension of more than 45 is unlikely to occur in such eyes, but the existence of a sharp borderline between the hypertensive reaction of nonglaucomatous and that of glaucomatous eyes in which the condition is early should not be expected, since there must be transitional states between the two.

I do not have a definite concept to offer with regard to the mechanism of the hypertensive reaction. Gonioscopic examination has shown that the hypertensive phase is not due to obstruction of the angle. The presence of amblyopia ex anopsia has no demonstrable relation to the hypertensive phase. The hypertensive reaction is quantitatively reproducible in the same person if the intervals between punctures are sufficiently long. If the punctures are repeated at intervals of two weeks or less, the hypertensive reaction tends to become less pronounced, the restoration time remaining unchanged.

The hypertensive reaction has often been explained as being due to the increased protein content of the reformed aqueous. My associates and I have not been able to recognize any parallelism between the protein content of the reformed fluid and the severity of the hypertensive reaction.

The hypotensive phase is slight and inconstant in nonglaucomatous eyes but can occasionally be demonstrated with certainty in the eyes of older patients.

In a little less than 10 per cent of the punctures done at the Illinois Eye and Ear Infirmary according to the standard technic, the needle track did not immediately become water tight, but fistulization set in, lasting from a few hours to two or three days. The presence of fistulization could be recognized by slit lamp examination as a spindle-shaped gaping of the needle track.

Owing to the shallowness of the chamber in glaucomatous eyes with narrow angles, the initial drop after puncture of the anterior chamber is not as marked as in glaucomatous eyes with wide angles, and in some cases a positive tonometric reading is obtained immediately after

the chamber has been completely emptied. The explanation for this phenomenon is that the fluid in the anterior chamber in these cases represents such a small portion of the total volume of the globe that the removal of the chamber contents is not sufficient to lower the pressure from, say, 25 mm. of mercury (Schiøtz) to below the tonometric range. If the intraocular pressure has been abnormally high before puncture, the phenomenon of residual tension after the chamber has been emptied may be very pronounced.

In glaucomatous eyes with narrow angles in which the ocular tension has been normal before puncture of the anterior chamber, the restoration time is found to be approximately the same as that of nonglaucomatous eyes of the same chamber depth. The hypertensive phase in such eyes may be pronounced, but in our series more often it was of the same or only slightly greater intensity than in the control eyes. This fact might also be worded by saying that a considerable number of eyes with narrow angle glaucoma are not "provoked" by puncture of the anterior chamber.

Under the term wide angle glaucoma are comprised the various forms of usually compensated, or noncongestive, glaucoma in which the tension is elevated although gonioscopic examination reveals no visible obstruction or anomaly of the angle except for the presence of unusual amounts of pigment in the trabeculae. Except for this fairly common finding, gonioscopy does not give any definite clue with regard to the mechanism of wide angle glaucoma. The restoration time in glaucomatous eyes with wide angles tends to be shorter than that of nonglaucomatous eyes of the same chamber depth. Since my series of cases is small and since the shorter restoration time is not found in every case of wide angle glaucoma, I am not sure enough of my finding a shorter restoration time in cases of wide angle glaucoma to postulate definitely that an abnormally rapid transfer of fluid into the eye takes place in this form of glaucoma. These observations, however, add weight to other findings, such as the results of oral administration of fluorescein, which tend to show that wide angle glaucoma is not due entirely to a disturbance of fluid outflow.

I believe that a pronounced hypertensive phase is characteristic of wide angle glaucoma. Since, however, the distinction between wide angle glaucoma and pseudoglaucoma (that is, optic nerve atrophy with complete excavation of the nerve head caused by a mechanism which is not that of glaucoma) is often difficult anl sometimes cannot be made unless the eye in question has been observed for several years, occasionally a typical glaucomatous excavation with an apparent glaucomatous field may be seen in an eye with normal or subnormal hypertensive reactions after puncture of the anterior chamber. I expect, however, that future observation of such eyes will show that their condition is pseudoglaucoma and not glaucoma.

A hypotensive phase rarely develops after puncture of the anterior chamber in wide angle glaucoma.

The response to puncture of the anterior chamber in cases of glaucoma associated with or preceded by uveitis and in cases of glaucoma caused by peripheral anterior synechias due to delayed reformation of the anterior chamber after an operation for cataract is briefly discussed.

In a discussion of the value of puncture of the anterior chamber for the early diagnosis of glaucoma before the Los Angeles Society of Ophthalmology and Otolaryngology, Dr. Clifford Walker, of Los Angeles, whose opinion I respect very much, stated that the risk of the procedure is too great in comparison with the value of the information to be obtained. I agree with him that the practical diagnostic value of the information obtained by puncture of the anterior chamber is not great, especially if the patient can be watched closely. To me, however, the study of the reactive processes which develop after puncture has been enlightening and has enabled me to understand the mechanism of many phenomena that I observe daily in the practice of clinical ophthalmology. I should be inclined to modify Dr. Walker's statement to read, "The risk entailed in properly executed puncture of the anterior chamber is small compared with the theoretic value of the information that can be obtained."

ALFRED COWAN, M.D., *Chairman*

WARREN S. REESE, M.D., *Secretary*

April 16, 1942

Total Bilateral Blindness Due to Lesions in Both Occipital Lobes.
DR. J. C. YASKIN and DR. A. S. TORNAY (by invitation).

Unilateral lesions in the geniculocalcarine tract which produce homonomous defects are common, but bilateral lesions are rare. Bilateral lesions are present in Shilder's disease and in vascular, neoplastic and traumatic lesions of both occipital lobes. If both occipital lobes are completely destroyed, total blindness results.

According to D. G. Marquis (*A. Research Nerv. & Ment. Dis., Proc.* **13:** 558, 1932) only 9 cases of complete blindness due to bilateral cerebral lesions were reported up to 1932. R. E. Hemphill (*Irish J. M. Sc.,* January 1941, p. 28) reported 2 cases of sudden complete blindness due to the occlusion of both posterior cerebral arteries. If the occipital poles are spared, central vision may remain intact. There has been evidence in some cases that the occipital pole is supplied by branches of both the middle cerebral and the posterior cerebral artery and that in vascular lesions the branch from the middle cerebral artery is spared, thus accounting for the preservation of macular vision.

Case Reports

The first patient was a 64 year old woman in whom after the death of her husband there developed a variety of complaints for which a neurosis was considered to be the basis. When first examined, on June 7, 1939, the patient was completely blind. The vision in the left eye had begun to diminish about six weeks previously, and blindness in that eye was complete in about three weeks. Complete blindness in the right eye developed during the two weeks previous to examination. Examination of the fundi and other ocular regions did not reveal any evidence of abnormality. At first the blindness was thought to be due

to hysteria. Abnormalities of a neurologic nature were not noted at first, but in the course of the next two months facial nerve palsy on the left side, bilateral pyramidal tract signs, slowness of the pulse, an increase in the spinal fluid pressure and enlargement of the glands in the neck developed, and carcinoma of the stomach was diagnosed by means of roentgenography. The patient died at her home, and an autopsy was not performed. It is reasonable to assume that her blindness was caused by metastatic carcinoma of both occipital lobes.

The second patient was a 51 year old syphilitic Negro whose vision had diminished during the previous two years and who had been completely blind for a few months. On Feb. 16, 1942, three days prior to his admission to the Philadelphia General Hospital, left hemiplegia developed. Examination revealed a blood pressure of 190 systolic and 150 diastolic, cardiac enlargement, left hemiparesis and hemihypalgesia, normal reactions of the pupils and, according to Dr. J. B. Rudolphy, no ophthalmologic findings to account for the total blindness. At autopsy extensive softening of both occipital lobes was noted.

Both patients were completely blind, exhibited loss of reflex lid closure to light illumination, had adequate reactions of the pupils to light stimulation and presented no abnormalities of the fundi to account for their blindness. It must be assumed that in both cases the occipital lobes were completely destroyed, in the first by a neoplasm and in the second by vascular softening. From a neuropsychiatric standpoint it is worth stressing that the first case was regarded for several weeks as one of "hysterical blindness."

DR. J. B. RUDOLPHY: I saw the second patient just prior to the time of his death. As a matter of fact, he died just after I examined him. When I saw him his condition was such that I could not learn much about his extraocular muscles. The lateral rotations were full, and the pupils had been dilated by means of homatropine, so that I could not tell whether they reacted or not. However, according to the report of a previous examination, they had reacted.

Ophthalmoscopic examination did not reveal ocular neuritis, papilledema or optic nerve atrophy. It did reveal marked sclerosis of the vessels. The fact that ophthalmoscopic examination did not reveal any pathologic changes in the optic nerve and that the patient was absolutely blind leaves no doubt that the lesion was within the visual cortex and occupied both occipital lobes.

As papilledema and optic nerve atrophy were not present, the lesion was probably degenerative rather than a tumor or a space-taking one.

DR. H. M. LANGDON: I should like to ask Dr. Yaskin one question about his first case. As I recall, he said that one eye became blind some weeks before the other, and hemianopia was not mentioned. How does he account for lesions in both occipital lobes, since one eye became blind three or four weeks before the other and the two halves of the visual fields apparently became involved simultaneously in each one? These seem like peculiar developments resulting from lesions in the occipital lobes.

DR. J. C. YASKIN: When I first saw the patient she was completely blind. When seen by her ophthalmologist, she complained of blindness in one eye, but apparently fields were not taken then. I do not

know whether the ophthalmologist made a diagnosis of a vascular arteriosclerotic lesion of the optic nerve. A diagnosis of hysteria had been made by the ophthalmologist who examined her, as well as by other consultants. I have no doubt that had fields been taken when the patient complained of the so-called blindness in the left eye, hemianopia would have been found.

DR. H. M. LANGDON: I believe that in making this diagnosis a great deal was assumed.

DR. J. C. YASKIN: I do not believe so. Even supratentorial tumors are often overlooked unless fields are taken carefully to define the hemianopia. Sometimes, also, cerebellar tumors grow large enough to produce pressure through the tentorium and give rise to confusing hemianoptic defects. On the other hand, I believe that blindness is often ascribed to rather insignificant changes in the retina, just as papilledema is often diagnosed on too little evidence. Moreover, in the case reported I believe that the assumption of the neurologist was far more reasonable than that of the other physicians who examined the patient.

Hydrophthalmos. DR. I. S. TASSMAN.

The subject of hydrophthalmos was reviewed briefly, and 3 boys suffering from the disease were presented The factors stressed were ocular hypertension and its relation to enlargement of the globe, structural alterations present in the angles of the eyes of patients with this disease, the importance of early surgical treatment and especially the choice of a trephining operation and the association in some cases of other changes, such as thickening and enlargement of the bones of the skull.

The first patient was a 6 year old boy in whom only the right eye was affected. The diameter of the cornea of this eye measured 18 mm. He had been seen first when he was 5 months old but had not been operated on until he was 4 years old, at which time an Elliot trephining operation was performed. The intraocular pressure in the right eye at the time of this report was 23 mm. of mercury (Schiøtz) and there were glaucomatous cupping of the disk and optic nerve atrophy. The vision was nil. No other complications were present.

The other 2 patients were first seen when they were 7 months and 12 months old, respectively. Both patients were large and unusually well developed for their age, and each had an unusually large head, which probably was not pathologic. The intraocular pressure had ranged from 40 to 45 mm. of mercury (Schiøtz) in each eye in both patients. The hydrophthalmos was bilateral in both. The corneas measured 18 mm. in diameter, and opacities were present in each cornea.

Photophobia had been so marked in 1 patient that he had buried his head in a pillow throughout the entire day in order to avoid light. A bilateral Elliot trephining operation was performed in July 1941 on the eyes of this patient. At the time of this report there was marked improvement in the vision and photophobia was almost entirely absent. The patient walked about alone and could tolerate almost any degree of light. He was a much happier child.

The other child had practically no photophobia, but in all other respects his case was similar to that of the former child. He had not been operated on yet, but an Elliot trephining operation was contemplated.

Special emphasis was placed on the unusually large cranium and the unusual muscular and physical development in association with the hydrophthalmos in these 2 patients and on the marked improvement in the ocular condition in the child who was operated on.

DR. W. E. FRY: A fair proportion of the students at an institution such as the Overbrook School for the Blind suffer from hydrophthalmos. Slightly less than half of the youngsters there are present because of blindness due to some congenital or hereditary defect. Twenty-two boys and girls with hydrophthalmos (8 per cent of the total) are there now, and of these I think 13 are boys and 9 are girls. The condition seems to occur more frequently in boys, but certainly not to a predominant extent.

Most of the youngsters who are in this school because of hydrophthalmos either are entirely blind or have only light perception. In looking over some of the records just the other day, I noticed that only 1 youngster suffering from hydrophthalmos had any recordable vision at all—1/150. In many of the children one eye has been enucleated and in some of them both eyes have been enucleated because owing to their prominence the eyes were subject to trauma. The children would bump into corners of doors or any other object that might be in their way, and as a result the globe would rupture and have to be removed.

Only 5 of the 22 children have been operated on for relief of the intraocular tension, and most of the operations have been trephinings. In spite of the fact that the prognosis is poor and in spite of the fact that operations to relieve the intraocular tension have not been numerous, it is my belief that such youngsters should be operated on. In all probability, even though vision could not be retained permanently it might be retained over a longer period.

DR. H. M. LANGDON: This is the first time that I have seen unilateral ophthalmos or hydrophthalmos. I believe that unilateral hydrophthalmos is sometimes due to a birth injury. I once observed secondary glaucoma in the eye of a child in whom a mark across the forehead and one across the eyeball were present which undoubtedly resulted from an injury at birth. The glaucoma was not due to stretching of the globe caused by congenital malformation.

There has been some discussion about changes in the anterior portion of the globe. One of the things that interests me is the fact that rarely does one see cupping of the disks of patients with hydrophthalmos. The tissues of the globes are so soft that it seems to me a great increase in the tension would be necessary to make the whole eyeball stretch as it does in the patients presented. Therefore, in all probability not until a much later period of the development of hydrophthalmos would real cupping of the disk be present.

I do not know whether any one has been able to follow a case long enough to observe that development. I never have, because patients with this disease seem to drift from one ophthalmologist to another. It is almost impossible to keep them under one's observation for any

length of time. However, it seems to me that cupping of the disk does not occur until late and probably is not as prevalent as it is in adult patients with glaucoma.

DR. H. G. SCHEIE: I have under my care a boy who had bilateral congenital glaucoma, or hydrophthalmos, and on whom I operated earlier this year with the assistance of Dr. F. H. Adler. A 6 year old sister of the patient is blind as a result of the disease and is a patient at the Overbrook School. I first saw the patient when he was between 6 and 7 months old. The pressure in each eye then measured between 40 and 50 mm. of mercury (Schiøtz). A diagnosis of bilateral congenital hydrophthalmos could be made readily because the corneas were very large and the globes were hard. The pressure was taken after the child had been admitted to the hospital and after he had been given heavy doses of a sedative. I had read Anderson's book in which advice is given concerning the type of operation to choose, and particularly that which should be performed on patients less than 1 year of age. Consequently, I trephined each eye.

The child has now been under my observation for nearly seven months. Since operation the pressure in each eye has never been more than 29 mm. of mercury (Schiøtz) and has varied from 22 to 22 mm. In accordance with Dr. Langdon's opinion, it has been interesting to note that the nerve heads have been normal even though the corneas did not show typical changes.

The last time the child was examined under an anesthetic I am sure that the disk could be considered normal in each eye, even in the eye in which a slightly higher pressure had been present. I believe Dr. Adler also examined the patient's eyes at that time.

DR. I. S. TASSMAN: Dr. Langdon might be correct in his observation that hydrophthalmos in the child whom he mentioned developed as a result of injury at birth. The interesting point about my first case is that the intraocular pressure was within normal limits and cupping of the disk was not present at the time I first saw the patient, when he was 5 months old. The anterior portion of the eye, however, appeared the same then as it does now. When the patient was 4 years old increased intraocular pressure developed, and at the present time (two years later) there is glaucomatous cupping of the disk and optic nerve atrophy.

It is difficult to see the ocular fundus of such patients because the cornea is hazy and often contains opacities. Also, the children are so young that it is almost impossible to get them to cooperate long enough for one to make the examination. I was not able to make a satisfactory ophthalmoscopic examination in either one of the last 2 cases reported.

White Rings in the Cornea (Coats). DR. J. WALDMAN.

White rings in the cornea were first described by Coats in 1912. Subsequently, other writers have reported this entity in the ophthalmic literature.

The ring is usually less than 1 mm. in diameter and causes no discomfort or visual defect. It is composed of a series of fifty or sixty chalky white tiny dots in Bowman's membrane. The overlying epithelium is intact except for an occasional slight depression. Pathologic

studies by some investigators have revealed localized degenerative disturbances in Bowman's membrane at the site of the ring. Hypotheses have also been advanced concerning trophic or toxic changes in the terminal corneal nerve endings as they pass through Bowman's membrane to the epithelium.

Five cases of white rings in the cornea were reported in this presentation. There had not been any other evidence biomicroscopically of corneal disturbances. In none of the reported cases was any visible corneal scarring associated. The location of most of the rings in the lower half of the cornea would seem to indicate that trauma is an etiologic factor. In my opinion, if routine biomicroscopy were included as a part of every ophthalmic examination, white rings in the cornea would be observed more often than the ophthalmic literature indicates.

DR. W. MENGEL: I cannot add anything to this excellent presentation. The condition probably occurs more frequently than one would expect, owing to the fact that a good many ophthalmologists do not routinely examine the cornea with the slit lamp.

White rings in the cornea represent a relatively clearcut condition and should be easily differentiated. Superficial punctate keratitis is definitely a different condition, as are nodular dystrophies of the cornea. There is a remote similarity between ordinary white corneal rings and the lesions caused by familial dystrophy, but differentiation between the two should not be difficult because of the fact that the ring-shaped opacities which represent familial dystrophy are situated in the superficial portion of the substantia propria and consist of hyaline infiltration. Ring-shaped opacities present in cases of familial dystrophy are ordinary developments. They are usually bilateral and progressive. One of the patients with ordinary white rings of the cornea whose case Dr. Waldman reported was observed for a period of five years, and during that time no particular change was noted. In such cases the rings are a great deal smaller than those which occur in cases of familial dystrophy, usually measuring only 0.5 mm. in diameter. For this reason a differential diagnosis should not be difficult to make.

It is interesting to speculate concerning the etiology of the lesions. In the majority of Dr. Waldman's patients they were located in the lower portion of the cornea. This would indicate the possibility of trauma.

Minute foreign bodies in the lower half of the cornea which penetrate the epithelium and stimulate Bowman's membrane could give rise to fatty infiltration in superficial portions of this membrane. In 3 of the cases reported the rings were situated 3 or 4 mm. from the limbus. Therefore, there is a possibility that inflammation or the presence of a toxin could be a factor in producing these rings.

I should like to ask Dr. Waldman where in the cornea the rings were located in the fifth case. In the first case they were in the center of the cornea, a typical location for white rings due to familial dystrophy. I should also like to ask whether other members of the family were found to have white rings in the cornea, which would indicate a possible familial trait.

DR. ALFRED COWAN: I have seen quite a few patients with ordinary white rings of the cornea. I think the lesions are fairly common, and I consider that they are the result of some slight trauma or a small

foreign body in the cornea. A small foreign body in the cornea almost always leaves a ring opacity if it does leave an opacity.

The fact that these lesions exist in Bowman's zone does not mean that the epithelium has not been damaged at the time of the injury. It does not mean that the condition started and ended in Bowman's zone. In the case of an abrasion or penetration of the epithelium, the epithelium nearly always heals over the resultant scar; so very likely in Dr. Waldman's patients the rings were the result of scars or fatty degeneration of scars. This is a common occurrence. I believe that nearly all lesions of this type result from scars caused by foreign bodies.

DR. J. WALDMAN: I should like to ask Dr. Cowan if he has seen white rings of the cornea associated with a definite corneal macula or nebula.

DR. ALFRED COWAN: I have never seen the rings in the upper portion of the cornea, but I did see them in association with a corneal macula in a patient whom I treated two weeks ago. A blast from a gas furnace discharged in the patient's face, and as a result his corneas were covered with dust particles. In three or four days tiny ringlike opacities could be seen to be forming.

DR. J. WALDMAN: In answer to Dr. Mengel's question, the corneal rings in my fifth case were located in the upper-outer quadrant at approximately 1 o'clock and about 3 mm. from the limbus. I did not examine any members of the families of the patients.

I have never seen a case similar to the one which Dr. Cowan has mentioned, in which a corneal macula was associated with corneal ringlike opacities; nor have I seen a case in which a corneal nebula was associated with the condition. MacRae has reported a case of white rings of the cornea in which a corneal nebula was present.

Förster's Syphilitic Choroiditis. DR. G. P. MEYER, Camden, N. J., and DR. J. V. KLAUDER (by invitation).

This report concerned a case of syphilitic chorioretinitis in which the syphilis had been acquired. The patient had been treated at Wills Hospital. The symptoms and signs of the disease were briefly described, and it was pointed out, as it had been by R. Förster in 1874, that the clinical manifestations are pathognomonic of syphilis. The disease occurs infrequently, and the fundus picture is occasionally confused with that associated with neuroretinitis, choroiditis of nonspecific origin and retinitis pigmentosa.

The most important diagnostic features are the characteristic field changes, which often simulate those of scotoma in which there is ring conformation. Erroneous diagnoses are made on the assumption that in the presence of syphilis all associated ocular lesions are syphilitic in nature.

Early recognition of syphilitic choroiditis is essential. The clinical manifestations are pathognomonic, and a diagnosis of syphilis can be verified early if the choroiditis is recognized in its primary development.

DISCUSSION

DR. J. V. KLAUDER: By the term syphilitic choroiditis Förster signified three interesting aspects of the disease: (1) its historical back-

ground, (2) its significance in making possible a classification of syphilitic ocular lesions and (3) its significant clinical manifestations.

From the historical standpoint it is interesting to note that Förster was professor of ophthalmology in the University of Breslau at the time Neisser discovered the gonococcus. It is interesting, also, to note the correlation of Förster's work on ocular syphilis with the clinical investigations concerning syphilis, which reached a high point during that period, the last fifty years of the nineteenth century. Also, Fournier and Hutchinson lived during that period. During the first twenty-five years of the twentieth century, the peak in the laboratory investigations concerning syphilis was reached.

I was not successful in obtaining a comprehensive conception of Förster's choroiditis from any textbook written in English. In some English textbooks it was discussed in as few as ten lines. Only by reading Förster's original paper (*Arch. Ophth.* **20:** 33-82, 1874) and the one by H. Rönne (*Acta ophth.* **12:** 1-37, 1934) did I obtain a proper conception of the disease.

Förster's work comprises one of the most interesting papers on the earlier clinical investigations concerning syphilis that I have read. He observed some patients for fifteen years before he published his paper. It records a minute clinical description of syphilitic ocular lesions. He was firm in his conviction that the disease is diagnostic of syphilis, and he maintained this opinion despite the patient's denial of infection. He presented records of cases in which he made a diagnosis of primary syphilis on the basis of ocular involvement. Such diagnoses were substantiated by other symptoms or by subsequent observation. Förster has inferred in his paper that in the early stage of the disease the ring scotoma is the feature that is of diagnostic import.

Förster pointed out that choroiditis appears first, usually, in the late secondary stage of syphilis, and he enumerated other symptoms prevalent in this stage that might be found on examination.

The onset of choroiditis during the early stage of syphilis is consistent with the present day conception that other syphilitic processes are initiated during this stage. After a period of dormancy, clinical symptoms appear. Particular reference is made to neurosyphilis and to aortitis. It is believed that clinical evidence of neurosyphilis occurs years after the nervous system has been invaded during the secondary stage of syphilis. Early in the course of neurosyphilis, the only evidence of the disease is a positive reaction of the spinal fluid to the Wassermann test. The onset of peripheral choroiditis that characterizes congenital syphilis in infants corresponds to the secondary stage of acquired syphilis. Uveitis due to acquired syphilis is much more likely to recur during the late secondary stage of syphilis than years later.

"Förster's choroiditis" connotes a disease process which invariably appears during the primary stage of syphilis. Its clinical manifestations vary somewhat, depending on what period in the course of the disease is represented when the patient is first examined. The outstanding diagnostic feature is a characteristic defect in the visual field. In any case in which one makes a diagnosis of choroiditis due to acquired syphilis it is pertinent to ask what the relation of this diagnosis is to that of Förster's choroiditis and what stage in the evolution of Förster's choroiditis is represented. It appears to me that this reasoning is more

desirable than that applied to making a diagnosis of acute or chronic disseminated choroiditis based chiefly on a positive Wassermann reaction.

In diagnosing syphilitic ocular lesions, I do not believe that one should disregard the stage of the systemic infection. The diagnosis should not be made solely on the basis of a positive Wassermann reaction. One should correlate the stage of the systemic infection, the serologic evidence and the response to antisyphilitic treatment. Another criterion, applicable chiefly to uveitis due to acquired syphilis, is the Herxheimer reaction. This reaction consists of a flare-up of the uveitis and is observed by means of slit lamp examination before and after the initial injection of an arsenical.

Rönne stated that aside from the disease Förster described there is only one type of choroiditis caused by syphilis, the rare form of central and peripheral choroiditis due to congenital syphilis.

Förster's choroiditis should be considered when one is making a diagnosis of disseminated choroiditis, neuroretinitis believed to be caused by syphilis and possibly, too, retinitis pigmentosa. Examination of the visual fields is necessary for verification of a ringlike scotoma when one is making a proper study of disseminated choroiditis thought to be caused by syphilis.

Ocular Lesion of Pyodermatitis Vegetans (Hallopeau's Disease; Dermatitis Vegetans). Dr. J. V. Klauder (by invitation).

Pyodermatitis vegetans is a benign inflammatory dermatosis characterized by the occurrence of bullae, or vesicopustular lesions, forming exuberant granulations and resulting in fungating, vegetating, condylomatous-like lesions. The disease favors the region of the orifices of the body. Numerous relapses occur, and the periods of remission may be of long duration. The predominating organism is Staphylococcus aureus. According to the reports made by W. N. Goldsmith (*Brit. J. Dermat.* **53:** 299, 1941) and by H. J. F. Wallhauser (*Arch. Dermat. & Syph.* **19:** 77 [Jan.] 1929), the disease at its onset is confined to mucous surfaces, appearing on cutaneous surfaces later.

Case Report.—A white man aged 28 gave a history that in 1937 a lesion developed on the mucous surface of his lower lip. It resembled an erosion, and its surface was studded with yellowish puncta resembling minute pustules. These punctate lesions could be removed by being rubbed with gauze, after which bleeding occurred. Later, similar lesions appeared on the floor of the mouth, the gums, the buccal mucosa, the nares and the septum. At times the condition would improve considerably or disappear for a short period; later, relapses would occur, during which the condition would vary in intensity.

In 1940 the process became pronounced, and papillomatous elevated lesions appeared on the lip and around the nares. These lesions resembled the illustration in Goldsmith's report They disappeared after the administration of sulfathiazole (2-[paraaminobenzenesulfonamido]-thiazole).

In 1941 the upper lid of the right eye became affected. The patient was seen by Dr. Alfred Cowan, who reported as follows: "The upper lid of the right eye is swollen, the margin being chiefly involved. The edge of the lid behind the cilia is eroded, and examination with the

slit lamp reveals a number of elevations containing puslike matter. Several of the hair follicles in this region are involved. There are an increase in the number of small blood vessels and considerable hemorrhagic exudate. The epidermis is absent over the area, and at the edge where it seems to terminate there is much desquamation. The pustules are not deep and involve only the superficial surface of the affected area. The surface has been gently curetted, and tincture of iodine has been applied."

The involvement of the eyelid disappeared in about three months and did not recur.

Histologic examination of the papillomatous lesion on the lip was not helpful in the diagnosis. Examination revealed only an inflammatory reaction. General physical and laboratory examinations gave essentially normal results except to disclose Staph. aureus in smears made at different times.

A varied treatment was employed. The following procedure seemed to be effective in causing disappearance of the lesions but not in preventing a relapse: Sulfathiazole was administered internally and also was applied in ointment form; solution of potassium arsenite was administered internally, and iodine crystals in creosote were applied locally.

At present there is only localized involvement in the upper gums and just inside the nares.

DISCUSSION

DR. J. V. KLAUDER: To my knowledge, conjunctival involvement in the nature of pyodermatitis vegetans has never before been reported. I believe, however, that the diagnosis in this case is justified despite the absence of cutaneous lesions, in view of the following features: the vegetating, papillomatous lesions on the lip and around the nares; the presence of pustules, which are always the conspicuous lesions; the remissions and relapses, and the presence of Staph. aureus. These features are characteristic of pyodermatitis vegetans.

This case illustrates the importance of properly examining all mucous surfaces when making a diagnosis of conjunctival lesions. Some diseases of the conjunctiva represent one phase of pathologic processes that favor mucous surfaces. In this respect, mention might be made of ocular pemphigus and of erythema multiforme.

Book Reviews

Motivation and Visual Factors. By I. E. Bender, H. A. Imus, J. W. M. Rothney, C. Kemple and M. R. England. Price, $4 postpaid. Pp. 369. Hanover, N. H.: Dartmouth College Publications, 1942.

In this review one encounters the somewhat anomalous situation of a psychologist discussing a book on vision for the benefit of ophthalmologists. The excuse must be that although this book has "visual" in the title and grew ultimately out of a program of research in physiologic optics, it is devoted largely to a consideration of problems of motivation and personal adjustment. The visual material seems to play a subordinate role in the total picture.

"Motivation and Visual Factors" is more or less a sequel to the earlier monograph from the Dartmouth Eye Institute entitled "An Evaluation of Visual Factors in Reading." The earlier study was statistical in nature, relating visual conditions, scholarship and reading ability for a substantial population of Dartmouth College students. The extensive survey showed only rather meager relations between visual factors and scholarship or reading. Stimulated by this lack of statistical relations, the authors were moved to make a more intensive examination of a limited number of subjects, hoping to achieve a better understanding of the visual factor through detailed study of a small number of persons.

Over the years, there has been a good deal of friendly controversy between exponents of an analytic (or statistical) attack on psychologic problems and the exponents of a synthetic (or clinical) approach. The present investigation represents an espousal of the synthetic, or clinical, approach. Using a wide range of psychologic technics—tests, interviews, ratings, autobiographic writings and so forth—and of visual measures, the authors have made an effort to build up a detailed and meaningful picture of each subject. The complete record for each one runs to some hundred pages but in the book is reduced to a ten or twelve page summary and interpretation. The bulk of the book is composed of such case records. These "psychoportraits" present fascinating pictures of real persons and make interesting reading. They freshen one's realization that the students who come to a college are diverse persons, with widely varied abilities, interests, ambitions, purposes and limitations. They highlight dramatically the importance of the individual's life pattern in determining his college actvities and achievements. They make one appropriately skeptical of any single simple explanation of college success and failure.

The emphasis on lack of uniformity—on the uniqueness of each individual—is good as far as it goes in discouraging facile and unwarranted generalizations. But the synthetic method seems to the reviewer to be less generous in positive and constructive contributions. Perhaps it is a major positive contribution to say that one must understand a person in detail before one can hope to estimate his probable college achievement. To the reviewer, however, this has a negative flavor. It is hard to draw from these individual case studies more specific, more definite and more positive generalizations than this. What the intensive

analysis of individuals does, in the last analysis, is document the survey finding that no single factor or pattern of factors provides or approaches providing a complete explanation of college success.

From the point of view of vision, likewise, the positive contribution of this study seems rather limited. The general finding is negative—that there is no clear relation between college achievement and the visual defects of the fairly mild sort shown by the group studied. The visual handicap is seen as one small facet of the total personality pattern. Beyond this, one can hardly go.

The part of the volume which may perhaps be of most interest to ophthalmologists is the appendix, in which are summarized the results of the visual measurement of the Dartmouth College class reported on.

PROF. R. L. THORNDIKE, Teachers College, Columbia University.

El Tracoma, Rebelde y Milenario. By A. Ros. Pp. 172. Mexico City: Editorial Cultura, 1941.

This monograph purports to be useful not only to specialists but to physicians and even to the general public. It is written in a literary style and gives the history of trachoma, its treatment and its prophylaxis.

The history is especially interesting, as the author describes the appearance of trachoma in Egypt, Greece, Rome and Spain. In separate chapters he deals with the blindness of great men in history, and he offers his opinion that the Greek poet Homer lost his sight from trachoma after a trip into Egypt and Italy before he went to Ithaca, where he made the plan for the Odyssey.

He believes that St. Francis of Assisi became blind from trachoma after a protracted illness with the disease. His opinion coincides with that of the historian Johannes Jorgeson, who asserted that St. Francis acquired trachoma in Egypt. The treatment given to the monk consisted of repeated cauterization of the temples with a hot iron, with no results but with a great deal of suffering.

Tobias the Biblical patriach, whose son Tobias cured his blindness by using the bile from a fish gallbladder, also probably had trachoma, according to Ros. He thinks that the angel made a thick white leukoma resulting from the disease disappear and thus cured the aged man.

Christ cured many persons of blindness, according to the New Testament. Ros believes the blindness of some was due to trachoma and was cured by shedding of the "scales" which covered the eyes, that is by clearing of the pannus or the leukoma. He does not, however, give any supporting facts for his views.

The chapter on blindness and diseases of the eye among the Aztecs in Mexico is particularly interesting. The author quotes old Spanish historians and Mexican authors who describe the prevalent diseases of the eye and their treatments. He believes that trachoma existed in Mexico, because there is mention in the histories that the Aztecs used a copper stone for rubbing diseased lids. They also used, probably for granulations, a rough bough called *camahualli,* with which they scraped the conjunctiva, washing the bleeding surface afterward with the alcoholic drink pulque.

This opinion, however, the reviewer considers far fetched, for trachoma has been and is a rare disease among the natives of Mexico.

In accordance with his own statistics, the reviewer thinks that there are no more than 4 or 5 cases among a thousand patients. Trachoma exists mainly among immigrants: Chinese, Syrians and others. Ros is misled when he quotes Chavez on the prevalence of the disease. Chavez asserted at one time that there was an epidemic of trachoma among the school children in Mexico which, if the reviewer remembers correctly, raised the percentage to about 20 or 40 per cent. This was not the case, since the follicular conjunctivitis of the epidemic healed without leaving any scars.

The chapter on the treatment of trachoma is mainly a list of medications employed through the ages. It is not up to date; for example, Ros does not mention the use of sulfanilamide. On the other hand, he recommends a solution of acetylsalicylic acid in water and glycerin. He does not give any supporting facts for this method.

The book ends with a good bibliography on trachoma, which includes 295 titles.

MANUEL URIBE TRONCOSO.

Contact Lenses. By Theodore E. Obrig. Price, $5.50. Pp. 470, with numerous illustrations. New York: The Chilton Company, 1942.

It is said that in the two and one-half years since Mr. Obrig introduced his all plastic molded contact lens, he has manufactured and dispensed more contact lenses than had been used throughout the world in the entire period before 1939. Drawing on this large experience, he has produced a book which, in spite of natural partisanship in favor of his own method, is a unique and satisfactory exposition of the history, fitting, manufacturing technic and therapeutic applicability of contact lenses. (The ophthalmologist reading this work, especially the chapters on anatomy and physiology, should bear in mind that it is written by a highly skilled nonmedical technician for a largely nonmedical audience.)

Physicians and patients will find here the answers to many troublesome questions about contact lenses: They will learn that vision equal to that with ordinary spectacles can be achieved in every case, that contact lenses are virtually invisible and that there is no record of their use being harmful to any eye. But one will seek in vain for assurance as to the length of time that contact lenses may be worn. Tolerance of the lens by the eye is still the greatest problem in the employment of contact lenses. Although cases are cited in which contact lenses have been worn day and night for periods up to two weeks, the great majority of patients find that the eye becomes irritated or the vision clouded after a certain number of hours, and the lenses must then be removed. The lenses generally can be worn for a minimum of four or five hours, a period which is usually sufficient for specific vocational or avocational uses. The author suggests that in some instances it may be necessary at first to remove the lenses and reinsert them with fresh solution at the end of two hours. The subject of tolerance is discussed exhaustively, and many helpful suggestions are offered to meet individual difficulties.

A section of the book is devoted to formulas for solutions, and in another large section there are reprinted the various patents on contact lenses filed with the United States Patent Office during the past forty years. This is a publication which will be interesting and valuable reading for every ophthalmologist and patient interested in contact lenses,

but it will probably have its largest circulation among the technicians concerned with fitting and dispensing these "invisible glasses."

GUERNSEY FREY.

Directory of Medical Specialists Certified by American Boards, 1942. Second edition. Price, $7. Pp. 2,495. New York: Columbia University Press, 1942.

The new edition of the "Directory of Medical Specialists," which was favorably reviewed on the occasion of its first publication, in 1940 (ARCH. OPHTH. 24: 615 [Sept.] 1940), contains complete information on 18,000 certified specialists. There are more than 4,000 new names, and in addition the information about each physician is more complete. It is needless to say that the directory is thus more useful and will be of great value to administrators in this period of the nation's great war effort.

Each American board gives a geographic and biographic list of the specialists certified and an alphabetical list with full information. Finally, the organization and the examination requirements of each of the boards are explained in full.

The directing editor continues to be Dr. Paul Titus, the associate editor J. Stewart Rodman and the advisory editorial board as follows: Dr. John Green, ophthalmology; Dr. W. P. Wherry, otolaryngology; Dr. Paul Titus, obstetrics and gynecology; Dr. C. Guy Lane, dermatology and syphilology; Dr. C. Anderson Aldrich, pediatrics; Dr. Walter Freeman, psychiatry and neurology; Dr. B. R. Kirklin, radiology; Dr. Guy A. Caldwell, orthopedic surgery; Dr. Gilbert J. Thomas, urology; Dr. W. S. Middleton, internal medicine; Dr. F. W. Hartman, pathology; Dr. J. Stewart Rodman, surgery; Dr. Paul M. Wood, anesthesiology; Dr. V. P. Blair, plastic surgery; Dr. R. Glen Spurling, neurologic surgery.

This improved edition reflects great credit on the labors of the editorial board, and the directory should prove to be indispensable to many.

ARNOLD KNAPP.

The Ophthalmic Formulary. Compiled by G. Griffin Lewis, M.D., Oculist to the Crouse-Irving Hospital, Syracuse, N. Y. Price, $3.50. Pp. 167. Springfield, Ill.: Charles C. Thomas, Publisher, 1942.

The dust jacket of this little volume informs the reader that it is an exclusive reference book for daily use. One finds here formulas from the prescription pads of some great ophthalmologists and of others not so great, past and present. While some of the therapeutic aids are in line with contemporary practice, many are superannuated or border on the "shotgun" type. The material does not seem to have been subjected to any critique. Among the conspicuously absent aids—to judge by the index—are prostigmine, thiamine hydrochloride, thyroxin, buffer solutions, sulfanilamide and its derivatives and the vitamins. Yet this little book is interesting as well as somewhat amusing, and the rather excessive price may be overlooked or considered compensated by its antiquarian rather than its contemporary significance.

PERCY FRIDENBERG.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6e, France.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the Secretariat, 66 Boulevard Saint-Michel, Paris, 6e, France.

International Ophthalmologic Congress

President: Prof. Nordenson, Serafimerlasarettet, Stockholm, Sweden.
Secretary: Dr. Ehlers, Jerbanenegade 41, Copenhagen, Denmark.

International Organization Against Trachoma

President: Dr. A. F. MacCallan, 17 Horseferry Rd., London, England.

Pan-American Congress of Ophthalmology

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Executive Secretaries: Dr. Conrad Berens, 35 E. 70th St., New York. Dr. M. E. Alvaro, 1511 Consolacao, São Paulo, Brazil.

FOREIGN

All-India Ophthalmological Society

President: Dr. B. K. Narayan Rao, Minto Ophthalmic Hospital, Bangalore.
Secretary: Dr. G. Zachariah, Flitcham, Marshall's Rd., Madras.

British Medical Association, Section on Ophthalmology

President: Dr. W. Clark Souter, 9 Albyn Pl., Aberdeen, Scotland.
Secretary: Dr. Frederick Ridley, 12 Wimpole St., London, W. 1.

Chinese Ophthalmology Society

President: Dr. C. H. Chou. 363 Avenue Haig, Shanghai.
Secretary: Dr. F. S. Tsang, 221 Foochow Rd., Shanghai.

Chinese Ophthalmological Society of Peiping

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

German Ophthalmological Society

President: Prof. W. Lohlein, Berlin.
Secretary: Prof. E. Engelking, Heidelberg.

Hungarian Ophthalmological Society

President: Prof. I. Iwre, Budapest.
Assistant Secretary: Dr. Stephen de Grósz, University Eye Hospital, Mária-utca 39, Budapest.
All corespondence should be addressed to the Assistant Secretary.

Midland Ophthalmological Society

President: Dr. W. Niccol, 4 College Green, Gloucester, England.
Secretary: Mr. T. Harrison Butler, 61 Newhall St., Birmingham 3, England.
Place: Birmingham and Midland Eye Hospital.

*Secretaries of societies are requested to furnish the information necessary to make this list complete and keep it up to date.

NORTH OF ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. A. MacRae, 6 Jesmond Rd., Newcastle-upon-Tyne, England.
Secretary: Dr. Percival J. Hay, 350 Glossop Rd., Sheffield 10, England.
Place: Manchester, Bradford, Leeds, Newcastle-upon-Tyne, Liverpool and Sheffield, in rotation. Time: October to April.

OPHTHALMOLOGICAL SOCIETY OF AUSTRALIA

President: Dr. A. James Flynn, 135 Macquarie St., Sydney.
Secretary: Dr. D. Williams, 193 Macquarie St., Sydney

OPHTHALMOLOGICAL SOCIETY OF EGYPT

President: Prof. Dr. Mohammed Mahfouz Bey, Government Hospital, Alexandria.
Secretary: Dr. Mohammed Khalil, 4 Baehler St., Cairo.
All correspondence should be addressed to the secretary, Dr. Mohammed Khalil.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

President: Mr. T. Harrison Butler, 61 Newhall St., Birmingham 3, England.
Secretary: Mr. L. H. Savin, 7 Queen St., London, W. 1, England.

OPHTHALMOLOGY SOCIETY OF BOMBAY

President: Dr. D. D. Sathaye, 127 Girgaum Rd., Bombay 4, India.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14, India.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time First Friday of every month.

OXFORD OPHTHALMOLOGICAL CONGRESS

Master: Dr. Percival J. Hay, 350 Glossop Rd., Sheffield 10, England.
Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.

PALESTINE OPHTHALMOLOGICAL SOCIETY

President: Dr. Arieh Feigenbaum, Abyssinian St. 15, Jerusalem.
Secretary: Dr. E. Sinai, Tel Aviv.

POLISH OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.
Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.
Place: Lindley'a 4, Warsaw.

ROYAL SOCIETY OF MEDICINE, SECTION OF OPHTHALMOLOGY

President: Dr. A. J. Ballantyne, 11 Sadyford Pl., Glosgow, C. 3, Scotland.
Secretary: Dr. C. Dee Shapland, 15 Devonshire Pl., London, W. 1, England.

SÃO PAULO SOCIETY OF OPHTHALMOLOGY

President: Dr. Jacques Tupinambo, 258 Inglezes, São Paulo, Brazil.
Secretary: Dr. Silvio de Almeido Toledo, Enfermaria Santa Luzia, Santa Casa de Misericordia, Cezario Motta St.—112, São Paulo, Brazil.

SOCIEDAD OFTALMOLOGIA DEL LITORAL, ROSARIO (ARGENTINA)

President: Prof. Dr. Carlos Weskamp, Laprida 1159, Rosario.
Secretary: Dr. Juan M. Vila Ortiz, Córdoba 1433, Rosario.
Place: Rosario. Time: Last Saturday of every month, April to November, inclusive.
All correspondence should be addressed to the President.

SOCIEDADE DE OPHTHALMOLOGIA E OTO RHINO-LARYNGOLOGIA DA BAHIA

President: Dr. Theonilo Amorim, Barra Avenida, Bahia, Brazil.
Secretary: Dr. Adroaldo de Alencar, Brazil.
All correspondence should be addressed to the President.

SOCIETÀ OFTALMOLOGICA ITALIANA

President: Prof. Dott. Giuseppe Ovio, Ophthalmological Clinic, University of Rome, Rome.
Secretary: Prof. Dott. Epimaco Leonardi, Via del Gianicolo, 1, Rome.

Société Française d'Ophthalmologie

Secretary: Dr. René Onfray, 6 Avenue de la Motte Picquet, Paris, 7e.

Society of Swedish Ophthalmologists

President: Prof. K. G. Ploman, Stockholm.
Secretary: Dr. K. O. Granström, Södermalmstorg 4 Ill tr., Stockholm, Sö.

Tel Aviv Ophthalmological Society

President: Dr. D. Arieh-Friedman, 96 Allenby St., Tel Aviv, Palestine.
Secretary: Dr. Sadger Max, 9 Bialik St., Tel Aviv, Palestine.

NATIONAL

American Medical Association, Scientific Assembly, Section on Ophthalmology

Chairman: Dr. Conrad Berens, 35 E. 70th St., New York City.
Secretary: Dr. Derrick Vail, 441 Vine St., Cincinnati.
Place: San Francisco.

American Academy of Ophthalmology and Otolaryngology, Section on Ophthalmology

President: Dr. Ralph I. Lloyd, 14–8th Ave., Brooklyn.
President-Elect: Dr. James A. Babbitt, 1912 Spruce St., Philadelphia.
Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

American Ophthalmological Society

President: Dr. Allen Greenwood, 82 Commonwealth Ave., Boston.
Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.

Association for Research in Ophthalmology, Inc.

Chairman: Dr. John Evans, 23 Schermerhorn St., Brooklyn.
Secretary-Treasurer: Dr. C. S. O'Brien, University Hospital, Iowa City.

Canadian Medical Association, Section on Ophthalmology

President: Dr. Alexander E. MacDonald, 170 St. George St., Toronto.
Secretary-Treasurer: Dr. L. J. Sebert, 170 St. George St., Toronto.

Canadian Ophthalmological Society

President: Dr. J. Vaillancourt, 46 St. Louis St., Quebec.
Secretary-Treasurer: Dr. Alexander E. MacDonald, 421 Medical Arts Bldg., Toronto.

National Society for the Prevention of Blindness

President: Mr. Mason H. Bigelow, 1790 Broadway, New York.
Secretary: Miss Regina E. Schneider, 1790 Broadway, New York.
Executive Director: Mrs. Eleanor Brown Merrill, 1790 Broadway, New York.

SECTIONAL

Academy of Medicine of Northern New Jersey, Section on Eye, Ear, Nose and Throat

President: Dr. Charles W. Barkhorn, 223 Roseville Ave., Newark.
Secretary: Dr. William F. McKim, 317 Roseville Ave., Newark.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

Central Wisconsin Society of Ophthalmology and Otolaryngology

President: Dr. D. G. Hugo, 130 Main St., Oshkosh.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.
Time: October 1942.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. William D. Rowland, 84 Commonwealth Ave., Boston.
Secretary-Treasurer: Dr. Trygve Gundersen, 243 Charles St., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston, Time: 8 p. m. third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. Ralph A. Fenton, 1020 S. W. Taylor St., Portland, Ore.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Spencer S. Howe, 103 E. Holly St., Bellingham, Wash.
Secretary-Treasurer: Dr. Barton E. Peden, 419 Stimson Bldg., Seattle.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month except June, July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. Sheldon Clark, 27 E. Stephenson St., Freeport, Ill.
Secretary-Treasurer: Dr. Harry R. Warner, 321 W. State St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of each month from October to April, inclusive.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. M. Kessler, 311 Center Ave., Bay City, Mich.
Secretary-Treasurer: Dr. J. H. Curts, 330 S. Washington Ave., Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month, except July and August.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. J. C. Davis, 1615 Howard St., Omaha.
Secretary-Treasurer: Dr. J. E. Dvorak, 408 Davidson Bldg., Sioux Falls, S. D.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. L. Chester McHenry, Medical Arts Bldg., Oklahoma City.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville, S. C.
Place: Richmond, Va. Time: November 1942.

SOUTHWESTERN ACADEMY OF EYE, EAR, NOSE AND THROAT

President: Dr. H. L. Brehmer, 221 W. Central Ave., Albuquerque, N. Mex.
Secretary: Dr. A. E. Cruthirds, 1011 Professional Bldg., Phoenix, Ariz.
Place: Albuquerque, N. Mex. Time: November 1942.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. W. M. Dodge, 716 First National Bank Bldg., Battle Creek.
Secretary-Treasurer: Dr. Kenneth Lowe, 25 W. Michigan Ave., Battle Creek.
Time: Last Thursday of September, October, November, March, April and May.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. C. H. Bailey, 29 S. Oakland Ave., Sharon.
Secretary-Treasurer: Dr. J. McClure Tyson, Deposit Nat'l Bank Bldg., DuBois.

STATE

ARKANSAS STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. R. R. Kirkpatrick, 6th and Walnut Sts., Texarkana, Ark.
Secretary-Treasurer: Dr. Raymond C. Cook, 701 Main St., Little Rock.

COLORADO OPHTHALMOLOGICAL SOCIETY

President: Dr. William M. Bane, 1612 Tremont Pl., Denver.
Secretary: Dr. Harry Shankel, Republic Bldg., Denver.
Place: University Club, Denver. Time: 7:30 p. m., third Saturday of each month, October to May, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. Edward N. DeWitt, 836 Myrtle Ave., Bridgeport.
Secretary-Treasurer: Dr. Henry L. Birge, 179 Allyn St., Hartford.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. E. N. Maner, 247 Bull St., Savannah.
Secretary-Treasurer: Dr. C. K. McLaughlin, 567 Walnut St., Macon.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. F. McK. Ruby, Union City.
Secretary: Dr. Edwin W. Dyar Jr., 23 E. Ohio St., Indianapolis.
Place: French Lick. Time: First Wednesday in April.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. J. K. Von Lackum, 117-3d St. S. E., Cedar Rapids.
Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.

LOUSIANA-MISSISSIPPI OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. Henry N. Blum, 912 American Bank Bldg., New Orleans.
Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Robert H. Fraser, 25 W. Michigan Ave., Battle Creek.
Secretary: Dr. R. G. Laird, 114 Fulton St., Grand Rapids.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Erling Wilhelm Hansen, 78 S. 9th St., Minneapolis.
Secretary-Treasurer: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.
Time: Second Friday of each month from October to May.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. William J. Marshall, 335 Owen St., Missoula.
Secretary: Dr. Fritz D. Hurd, 309 Medical Arts Bldg., Great Falls.

NEBRASKA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.
Secretary-Treasurer: Dr. John Peterson, 1307 N St., Lincoln.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY, OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. Edgar P. Cardwell, 47 Central Ave., Newark.
Secretary: Dr. Arthur E. Sherman, 243 S. Harrison St., East Orange.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. Searle B. Marlow, 109 S. Warren St., Syracuse.
Secretary: Dr. C. Stewart Nash, 277 Alexander St., Rochester.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. M. R. Gibson, Professional Bldg., Raleigh.
Secretary: Dr. Vanderbilt F. Couch, 105 W. 4th St., Winston-Salem.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. G. A. Larson, 114 Roberts St., Fargo.
Secretary-Treasurer: Dr. F. L. Wicks, 516–6th St., Valley City.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Paul Bailey, 833 S. W. 11th Ave., Portland.
Secretary-Treasurer: Dr. R. S. Fixott, 1020 S. W. Taylor St., Portland.
Place: Good Samaritan Hospital, Portland. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
Place: Rhode Island Medical Society Library, Providence. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. J. L. Sanders, 222 N. Main St., Greenville.
Secretary: Dr. J. H. Stokes, 125 W. Cheves St., Florence.
Place: Columbia. Time: November 1942.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Wesley Wilkerson, 700 Church St., Nashville.
Secretary-Treasurer: Dr. W. D. Stinson, 124 Physicians and Surgeons Bldg., Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. E. L. Goar, 1300 Walker Ave., Houston.
Secretary: Dr. Dan Brannin, 929 Medical Arts Bldg., Dallas.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. Everett B. Muir, Boston Bldg., Salt Lake City.
Secretary-Treasurer: Dr. Earl H. Phillips, 623 Judge Bldg., Salt Lake City.
Place: University Club, Salt Lake City. Time: 7:00 p. m., third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. Mortimer H. Williams, 30½ Franklin Rd. S. W., Roanoke.
Secretary-Treasurer: Dr. Meade Edmunds, 34 Franklin St., Petersburg.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

AKRON ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. George E. Ferguson, Second National Bldg., Akron, Ohio.
Secretary-Treasurer: Dr. D. F. Mathias, First Central Tower, Akron, Ohio.
Time: First Monday in January, March, May and November.

ATLANTA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Stacy C. Howell, 144 Ponce de Leon Ave. N. E., Atlanta, Ga.
Secretary: Dr. Lester A. Brown, 478 Peachtree St. N. E., Atlanta, Ga.
Place: Grady Hospital. Time: 6:00 p. m., second Wednesday of each month, from October to May.

BALTIMORE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Ernst Bodenheimer, 1212 Eutaw Pl., Baltimore.
Secretary: Dr. Thomas R. O'Rourk, 104 W. Madison St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to March.

Birmingham Eye, Ear, Nose and Throat Club

President: Each member, in alphabetical order.
Secretary: Dr. Luther E. Wilson, 919 Woodward Bldg., Birmingham, Ala.
Place: Tutwiler Hotel. Time: 6:30 p. m., second Tuesday of each month, September to May, inclusive.

Brooklyn Ophthalmological Society

President: Dr. William B. Agan, 1 Nevins St., Brooklyn.
Secretary-Treasurer: Dr. Benjamin C. Rosenthal, 140 New York Ave., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. Meyer H. Riwchun, 367 Linwood Ave., Buffalo.
Secretary-Treasurer: Dr. Sheldon B. Freeman, 196 Linwood Ave., Buffalo.
Time: Second Thursday of each month.

Chattanooga Society of Ophthalmology and Otolaryngology

President: Each member, in alphabetical order.
Secretary: Dr. Douglas Chamberlain, Chattanooga Bank Bldg., Chattanooga, Tenn.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

Chicago Ophthalmological Society

President: Dr. Sanford Gifford, 720 N. Michigan Ave., Chicago.
Secretary-Treasurer: Dr. Vernon M. Leech, 55 E. Washington St., Chicago.
Place: Chicago Towers Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cincinnati General Hospital Ophthalmology Staff

Chairman: Dr. D. T. Vail, 441 Vine St., Cincinnati.
Secretary: Dr. A. A. Levin, 441 Vine St., Cincinnati.
Place: Cincinnati General Hospital. Time: 7:45 p. m., third Friday of each month except June, July and August.

Cleveland Ophthalmological Club

Chairman: Dr. W. J. Abbott, 10515 Carnegie Ave., Cleveland.
Secretary: Dr. L. V. Johnson, 2065 Adelbert Rd., Cleveland.
Time: Second Tuesday in October, December, February and April.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. Francis H. Adler, 313 S. 17th St., Philadelphia.
Clerk: Dr. W. S. Reese, 1901 Walnut St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. C. D. Postle, 240 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. Hugh C. Thompson, 289 E. State St., Columbus, Ohio.
Place: The Neil House. Time: 6 p. m., first Monday of each month.

Corpus Christi Eye, Ear, Nose and Throat Society

Chairman: Dr. F. K. Stroud, 416 Chaparral St., Corpus Christi, Texas.
Secretary: Dr. Arthur Padilla, 414 Medical Professional Bldg., Corpus christi, Texas.
Time: Second Friday of each month from October to May.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. S. F. Harrington, 921 Medical Arts Bldg., Dallas, Texas.
Secretary: Dr. Abell Hardin, Medical Arts Bldg., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. H. C. Schmitz, 604 Locust St., Des Moines, Iowa.
Secretary-Treasurer: Dr. Byron M. Merkel, 604 Locust St., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month from September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Harvey E. Dowling, 2414 Eaton Tower, Detroit.
Time: 6:30 p. m., first Wednesday of each month.

Detroit Ophthalmological Society

President: Dr. Parker Heath, 1553 Woodward Ave., Detroit.
Secretary: Dr. Leland F. Carter, 1553 Woodward Ave., Detroit.
Place: Club rooms of Wayne County Medical Society. Time: Third Thursday of each month from November to April, inclusive.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. James M. Dunn, 1352 Union St., Schenectady.
Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

Eastern Pennsylvania Association of Eye, Ear, Nose and Throat Physicians

President: Dr. James E. Landis, 232 N. 6th St., Reading.
Secretary-Treasurer: Dr. Sterling F. Mengel, 612 W. Market St., Pottsville.
Time: Last week in April each year.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. W. R. Thompson, 602 W. 10th St., Fort Worth, Texas.
Secretary-Treasurer: Dr. A. E. Jackson, 602 W. 10th St., Fort Worth, Texas.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

Houston Academy of Medicine, Ophthalmological and Oto-Laryngological Section

President: Dr. Felician J. Slataper, 1110-1111 Medical Arts Bldg., Houston, Texas.
Secretary: Dr. Theo. L. Holland, 611 Medical Arts Bldg., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

Indianapolis Ophthalmological and Otolaryngological Society

President: Dr. John I. Garret, 57 Stokes Bldg., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: Indianapolis Athletic Club. Time: 6:30 p. m., second Thursday of each month from November to May.

Kansas City Society of Ophthalmology and Oto-Laryngology

President: Dr. Homer Beal, 1103 Grand Ave., Kansas City, Mo.
Secretary: Dr. Desmond Curran, Federal Reserve Bank Bldg., Kansas City, Mo.
Time: Third Thursday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

Chairman: Dr. Harold Snow, 614 S. Pacific Ave., San Pedro, Calif.
Secretary-Treasurer: Dr. Oliver R. Nees, 508 Times Bldg., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

Los Angeles Society of Ophthalmology and Otolaryngology

President: Dr. John Osburn, 523 W. 6th St., Los Angeles.
Secretary-Treasurer: Dr. Colby Hall, 1136 W. 6th St., Los Angeles.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:00 p. m., fourth Monday of each month from September to May, inclusive.

Louisville Eye and Ear Society

President: Dr. Joseph S. Heitger, Heyburn Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. J. W. Fish, 321 W. Broadway, Louisville, Ky.
Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

Lower Anthracite Eye, Ear, Nose and Throat Society

Chairman: Each member in alphabetical order.
Secretary: Dr. James J. Monohan, 31 S. Jardin St., Shenandoah, Pa.

Medical Society of the District of Columbia, Section of Ophthalmology and Otolaryngology

Chairman: Dr. E. J. Cummings, 1835 I St. N. W., Washington.
Secretary: Dr. P. S. Constantinople, 1835 I St. N. W., Washington.
Place: 1718 M St. N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

Memphis Society of Ophthalmology and Otolaryngology

Chairman: Each member in alphabetical order.
Secretary: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month from September to May.

Milwaukee Oto-Ophthalmic Society

President: Dr. John W. Truitt, 161 W. Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. Ralph T. Rank, 238 W. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

Montgomery County Medical Society

Chairman: Dr. H. V. Dutrow, 1040 Fidelity Medical Bldg., Dayton, Ohio.
Secretary-Treasurer: Dr. Maitland D. Place, 981 Reibold Bldg., Dayton, Ohio.
Place: Van Cleve Hotel. Time: 6:30 p. m., first Tuesday of each month from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. J. Rosenbaum, 1396 Ste. Catherine St. W., Montreal, Canada.
Secretary: Dr. L. Tessier, 1230 St. Joseph Blvd. E., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Andrew Hollabaugh, Doctors Bldg., Nashville, Tenn.
Secretary: Dr. Guy Maness, Medical Arts Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

New Haven Ophthalmological Society

President: Dr. William H. Ryder, 185 Church St., New Haven, Conn.
Secretary: Dr. Frederick A. Wiess, 255 Bradley St., New Haven, Conn.

New Orleans Ophthalmological and Otolaryngological Society

President: Dr. W. B. Clark, 1012 American Bank Bldg., New Orleans.
Secretary: Dr. Mercer G. Lynch, 1018 Maison Blanche Bldg., New Orleans.
Place: Louisiana State University Medical Bldg. Time: 8 p. m., second Tuesday of each month from October to May.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. Kaufman Schlivek, 1016–5th Ave., New York.
Secretary: Dr. Brittain Payne, 896 Madison Ave., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

President: Dr. Isidore Givner, 108 E. 66th St., New York.
Secretary: Dr. Benjamin Esterman, 983 Park Ave., New York.
Place: Squibb Hall, 745–5th Ave. Time: 8 p. m., first Monday of each month from October to May, inclusive.

OKLAHOMA CITY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. R. E. Leatherock, Cushing, Okla.
Secretary: Dr. Harry C. Ford, 1014 Medical Arts Bldg., Oklahoma City.
Place: University Hospital. Time: Second Tuesday of each month from September to May.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Leo P. Coakley, 918 Medical Arts Bldg., Omaha.
Secretary-Treasurer: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m. dinner; 7 p. m., program; third Wednesday of each month from October to May.

PASSAIC-BERGEN OPHTHALMOLOGICAL CLUB

President: Dr. L. Markowitz, 16 Church St., Paterson, N. J.
Secretary-Treasurer: Dr. A. John Reinhorn, 302 Broadway, Paterson, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

PHILADELPHIA COUNTY MEDICAL SOCIETY, EYE SECTION

Chairman: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.
Secretary: Dr. Wilfred E. Fry, 1819 Chestnut St., Philadelphia.
Time: First Thursday of each month from October to May.

PITTSBURGH OPHTHALMOLGICAL SOCIETY

President: Dr. Hunter H. Turner, 717 Liberty Ave., Pittsburgh.
Secretary: Dr. George H. Shuman, 351–5th Ave., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

READING EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Solon L. Rhode, 238 N. 6th St., Reading, Pa.
Secretary: Dr. Paul C. Craig, 232 N. 5th St., Reading, Pa.
Place: Wyomissing Club. Time: 6:30 p. m., third Wednesday of each month from October to July.

RICHMOND OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. W. F. Bryce, Medical Arts Bldg., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. E. J. Avery, 11 N. Goodman St., Rochester N. Y.
Secretary-Treasurer: Dr. Charles T. Sullivan, 277 Alexander St., Rochester, N. Y.

St. Louis Ophthalmic Society

President: Dr. William M. James, 508 N. Grand Blvd., St. Louis.
Secretary: Dr. H. Rommel Hildreth, 823 Metropolitan Bldg., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting, 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

San Antonio Ophthalmo-Oto-Laryngological Society

President: Dr. Dan Russell, 705 E. Houston St., San Antonio, Texas.
Secretary-Treasurer: Dr. P. G. Bowen, 315 Camden St., San Antonio, Texas,
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Fred Boyle, 490 Post St., San Francisco.
Secretary: Dr. Frank Hand, 450 Sutter St., San Francisco.
Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except June, July and December.

Shreveport Eye, Ear, Nose and Throat Society

President: Dr. David C. Swearingen, Slattery Bldg., Shreveport, La.
Secretary-Treasurer: Dr. Kenneth Jones, Medical Arts Bldg., Shreveport, La.
Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. Louis A. Parsell, 407 Riverside Ave., Spokane, Wash.
Secretary: Dr. Robert L. Pohl, 407 Riverside Ave., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. Roy Seeley Moore, 1704 State Tower Bldg., Syracuse, N. Y.
Secretary-Treasurer: Dr. I. H. Blaisdell, 713 E. Genesee St., Syracuse, N. Y.
Place: University Club. Time: First Tuesday of each month except June, July and August.

Toledo Eye, Ear, Nose and Throat Society

Chairman: Dr. John D. Skow, 2001 Collingwood Blvd., Toledo, Ohio.
Secretary: Dr. S. H. Patterson, 125–15th Ave., Toledo, Ohio.
Place: Toledo Club. Time: Each month except June, July and August.

Toronto Academy of Medicine, Section of Ophthalmology

Chairman: Dr. W. R. F. Luke, 316 Medical Arts Bldg., Toronto, Canada.
Secretary: Dr. W. T. Gratton, 216 Medical Arts Bldg., Toronto, Canada.
Place: Academy of Medicine, 13 Queens Park. Time: First Monday of each month, November to April.

Washington, D. C., Ophthalmological Society

President: Dr. E. Leonard Goodman, 1801 I St. N. W., Washington, D. C.
Secretary-Treasurer: Dr. Sterling Bockoven, 1752 Massachusetts Ave. N. W., Washington, D. C.
Place: Episcopal Eye, Ear and Throat Hospital. Time: 7:30 p. m., first Monday in November, January, March and April.

Wilkes-Barre Ophthalmological Society

Chairman: Each member in turn.
Secretary: Dr. Samuel T. Buckman, 70 S. Franklin St., Wilkes-Barre, Pa.
Place: Office of chairman. Time: Last Tuesday of each month from October to May.